

# Microsoft® GW-BASIC

## User's Guide

This guide is designed to help you use the GW-BASIC Interpreter with the MS-DOS (R) operating system. Section 1.5 lists resources that will teach you how to program. 1987

## User's Reference

This manual is an alphabetical reference to GW-BASIC instructions: statements, functions, commands, and variables. 1987

# GW-BASIC User's Guide

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# Microsoft (R) GW-BASIC Interpreter User's Guide

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# 1 Welcome to GW-BASIC

Microsoft (R) GW-BASIC (R) is a simple, easy-to-learn, easy-to-use computer programming language with English-like statements and mathematical notations. With GW-BASIC you will be able to write both simple and complex programs to run on your computer. You will also be able to modify existing software that is written in GW-BASIC.

This guide is designed to help you use the GW-BASIC Interpreter with the MS-DOS (R) operating system. Section 1.5 lists resources that will teach you how to program.

## 1.1 System Requirements

This version of GW-BASIC requires MS-DOS version 3.2 or later.

## 1.2 Preliminaries

Your GW-BASIC files will be on the MS-DOS diskette located at the back of the MS-DOS User's Reference. Be sure to make a working copy of the diskette before you proceed.

### Note

This manual is written for the user familiar with the MS-DOS operating system. For more information on MS-DOS, refer to the Microsoft MS-DOS 3.2 User's Guide and User's Reference.

## 1.3 Notational Conventions

Throughout this manual, the following conventions are used to distinguish elements of text:

- **bold** Used for commands, options, switches, and literal portions of syntax that must appear exactly as shown.
- *italic* Used for filenames, variables, and placeholders that represent the type of text to be entered by the user.
- `monospace` Used for sample command lines, program code and examples, and sample sessions.
- **SMALL CAPS** Used for keys, key sequences, and acronyms.
- [Brackets] surround optional command-line elements.

## 1.4 Organization of This Manual

The GW-BASIC User's Guide is divided into six chapters, nine appendixes, and a glossary:

Chapter 1, "Welcome to GW-BASIC," describes this manual.

Chapter 2, "Getting Started With GW-BASIC," is an elementary guideline on how to begin programming.

Chapter 3, "Reviewing and Practicing GW-BASIC," lets you use the principles of GW-BASIC explained in Chapter 2.

Chapter 4, "The GW-BASIC Screen Editor," discusses editing commands that can be used when inputting or modifying a GW-BASIC program. It also explains the unique properties of the ten redefinable function keys and of other keys and keystroke combinations.

Chapter 5, "Creating and Using Files," tells you how to create files and to use the diskette input/output (I/O) procedures.

Chapter 6, "Constants, Variables, Expressions, and Operators," defines the elements of GW-BASIC and describes how you will use them.

Appendix A, "Error Codes and Messages," is a summary of all the error codes and error messages that you might encounter while using GW-BASIC.

Appendix B, "Mathematical Functions," describes how to calculate certain mathematical functions not intrinsic to GW-BASIC.

Appendix C, "ASCII Character Codes," lists the ASCII character codes recognized by GW-BASIC.

Appendix D, "Assembly Language (Machine Code) Subroutines," shows how to include assembly language subroutines with GW-BASIC.

Appendix E, "Converting BASIC Programs to GW-BASIC," provides pointers on converting programs written in BASIC to GW-BASIC.

Appendix F, "Communications," describes the GW-BASIC statements required to support RS-232 asynchronous communications with other computers and peripheral devices.

Appendix G, "Hexadecimal Equivalents," lists decimal and binary equivalents to hexadecimal values.

Appendix H, "Key Scan Codes," lists and illustrates the key scan code values used in GW-BASIC.

Appendix I, "Characters Recognized by GW-BASIC," describes the GW-BASIC character set.

The Glossary defines words and phrases commonly used in GW-BASIC and data processing.

## 1.5 Bibliography

This manual is a guide to the use of the GW-BASIC Interpreter: it makes no attempt to teach the BASIC programming language. The following texts may be useful for those who wish to learn BASIC programming:

- Albrecht, Robert L., LeRoy Finkel, and Jerry Brown. BASIC. 2d ed. New York: Wiley Interscience, 1978.
- Coan, James. Basic BASIC. Rochelle Park, N.J.: Hayden Book Company, 1978.
- Dwyer, Thomas A. and Margot Critchfield. BASIC and the Personal Computer. Reading, Mass.: Addison-Wesley Publishing Co., 1978.
- Ettlin, Walter A. and Gregory Solberg. The MBASIC Handbook. Berkeley, Calif.: Osborne/McGraw Hill, 1983.
- Knecht, Ken. Microsoft BASIC. Portland, Oreg.: Dilithium Press, 1982.

## 2 Getting Started With GW-BASIC

This chapter describes how to load GW-BASIC into your system. It also explains the two different types of operation modes, line formats, and the various elements of GW-BASIC.

### 2.1 Loading GW-BASIC

To use the GW-BASIC language, you must load it into the memory of your computer from your working copy of the MS-DOS diskette. Use the following procedure:

1. Turn on your computer.
2. Insert your working copy of the MS-DOS diskette into Drive A of your computer, and press RETURN.
3. Type the following command after the A> prompt, and press RETURN:

```
gwbasic
```

Once you enter GW-BASIC, the GW-BASIC prompt, Ok, will replace the MS-DOS prompt, A>.

On the screen, the line XXXXX Bytes Free indicates how many bytes are available for use in memory while using GW-BASIC.

The function key (F1 - F10) assignments appear on the bottom line of the screen. These function keys can be used to eliminate key strokes and save you time. Chapter 4, "The GW-BASIC Screen Editor," contains detailed information on function keys.

## 2.2 Modes of Operation

Once GW-BASIC is initialized (loaded), it displays the Ok prompt. Ok means GW-BASIC is at command level; that is, it is ready to accept commands. At this point, GW-BASIC may be used in either of two modes: direct mode or indirect mode.

### 2.2.1 Direct Mode

In the direct mode, GW-BASIC statements and commands are executed as they are entered. Results of arithmetic and logical operations can be displayed immediately and/or stored for later use, but the instructions themselves are lost after execution. This mode is useful for debugging and for using GW-BASIC as a calculator for quick computations that do not require a complete program.

### 2.2.2 Indirect Mode

The indirect mode is used to enter programs. Program lines are always preceded by line numbers, and are stored in memory. The program stored in memory is executed by entering the RUN command.

## 2.3 The GW-BASIC Command Line Format

The GW-BASIC command line lets you change the environment or the conditions that apply while using GW-BASIC.

### Note

When you specify modifications to the operating environment of GW-BASIC, be sure to maintain the parameter sequence shown in the syntax statement. To skip a parameter, insert a comma. This will let the computer know that you have no changes to that particular parameter.

GW-BASIC uses a command line of the following form:

```
gwbasic[filename][<stdin][>>stdout][/f:n][/i][/s:n][/c:n][/m:[n][,n]][/d]
```

filename is the name of a GW-BASIC program file. If this parameter is present, GW-BASIC proceeds as if a RUN command had been given. If no extension is provided for the filename, a default file extension of .BAS is assumed. The .BAS extension indicates that the file is a GW-BASIC file. The maximum number of characters a filename may contain is eight with a decimal and three extension characters.

<stdin redirects GW-BASIC's standard input to be read from the specified file. When used, it must appear before any switches.

This might be used when you have multiple files that might be used by your program and you wish to specify a particular input file.

>stdout redirects GW-BASIC's standard output to the specified file or device. When used, it must appear before any switches. Using >> before stdout causes



output to be appended.

GW-BASIC can be redirected to read from standard input (keyboard) and write to standard output (screen) by providing the input and output filenames on the command line as follows:

gwbasic program name <input file[>]>output file

An explanation of file redirection follows this discussion of the GW-BASIC command line.

Switches appear frequently in command lines; they designate a specified course of action for the command, as opposed to using the default for that setting. A switch parameter is preceded by a slash (/).

/f:n sets the maximum number of files that may be opened simultaneously during the execution of a GW-BASIC program. Each file requires 194 bytes for the File Control Block (FCB) plus 128 bytes for the data buffer. The data buffer size may be altered with the /s: switch. If the /f: switch is omitted, the maximum number of open files defaults to 3. This switch is ignored unless the /i switch is also specified on the command line.

/i makes GW-BASIC statically allocate space required for file operations, based on the /s and /f switches.

/s:n sets the maximum record length allowed for use with files. The record length option in the OPEN statement cannot exceed this value. If the /s: switch is omitted, the record length defaults to 128 bytes. The maximum record size is 32767.

/c:n controls RS-232 communications. If RS-232 cards are present, /c:0 disables RS-232 support, and any subsequent I/O attempts for each RS-232 card present. If the /c: switch is omitted, 256 bytes are allocated for the receive buffer and 128 bytes for the transmit buffer for each card present.

The /c: switch has no affect when RS-232 cards are not present. The /c:n switch allocates n bytes for the receive buffer and 128 bytes for the transmit buffer for each RS-232 card present.

/m:n[, n] sets the highest memory location (first n) and maximum block size (second n) used by GW-BASIC. GW-BASIC attempts to allocate 64K bytes of memory for the data and stack segments. If machine language subroutines are to be used with GW-BASIC programs, use the /m: switch to set the highest location that GW-BASIC can use. The maximum block size is in multiples of 16. It is used to reserve space for user programs (assembly language subroutines) beyond GW-BASIC's workspace.

The default for maximum block size is the highest memory location. The default for the highest memory location is 64K bytes unless maximum block size is specified, in which case the default is the maximum block size (in multiples of 16).

/d allows certain functions to return double-precision results. When the /d switch is specified, approximately 3000 bytes of additional code space are used. The functions affected are ATN, COS, EXP, LOG, SIN, SQR, and TAN.

## Note

All switch numbers may be specified as decimal, octal (preceded by &O), or hexadecimal (preceded by &H).

Sample GW-BASIC command lines are as follows:

The following uses 64K bytes of memory and three files; loads and executes the program file payroll.bas:

```
A>gwbasic PAYROLL
```

The following uses 64K bytes of memory and six files; loads and executes the program file invent.bas:

```
A>gwbasic INVENT /F: 6
```

The following disables RS-232 support and uses only the first 32K bytes of memory. 32K bytes above that are reserved for user programs:

```
A>gwbasic /C: 0 /M: 32768, 4096
```

The following uses four files and allows a maximum record length of 512 bytes:

```
A>gwbasic /F: 4 /S: 512
```

The following uses 64K bytes of memory and three files. Allocates 512 bytes to RS-232 receive buffers and 128 bytes to transmit buffers, and loads and Executes the program file tty.bas:

```
A>gwbasic TTY /C: 512
```

For more information about RS-232 Communications, see Appendix F.

## Redirection of Standard Input and Output

When redirected, all INPUT, LINE INPUT, INPUT\$, and INKEY\$ statements are read from the specified input file instead of the keyboard.

All PRINT statements write to the specified output file instead of the screen.

Error messages go to standard output and to the screen.

File input from KYBD: is still read from the keyboard.

File output to SCRN: still outputs to the screen.

GW-BASIC continues to trap keys when the ON KEY n statement is used.

Typing CTRL-BREAK when output is redirected causes GW-BASIC to close any open files, issue the message "Break in line nnnn" to standard output, exit GW-BASIC, and return to MS-DOS.

When input is redirected, GW-BASIC continues to read from this source until a CTRL-Z is detected. This condition can be tested with the end-of-file (EOF)

function. If the file is not terminated by a CTRL-Z, or if a GW-BASIC file input statement tries to read past the end of file, then any open files are closed, and GW-BASIC returns to MS-DOS.

For further information about these statements and other statements, functions, commands, and variables mentioned in this text, refer to the GW-BASIC User's Reference.

Some examples of redirection follow.

```
GW BASIC MYPROG >DATA. OUT
```

Data read by the INPUT and LINE INPUT statements continues to come from the keyboard. Data output by the PRINT statement goes into the data.out file.

```
gwbasic MYPROG <DATA. IN
```

Data read by the INPUT and LINE INPUT statements comes from data.in. Data output by PRINT continues to go to the screen.

```
gwbasic MYPROG <MYINPUT. DAT >MYOUTPUT. DAT
```

Data read by the INPUT and LINE INPUT statements now come from the file myinput.dat, and data output by the PRINT statements goes into myoutput.dat.

```
gwbasic MYPROG <\SALES\JOHN\TRANS. DAT >>\SALES\SALES. DAT
```

Data read by the INPUT and LINE INPUT statements now comes from the file \sales\john\trans.dat. Data output by the PRINT statement is appended to the file \sales\sales.dat.

## 2.4 GW-BASIC Statements, Functions, Commands, and Variables

A GW-BASIC program is made up of several elements: keywords, commands, statements, functions, and variables.

### 2.4.1 Keywords

GW-BASIC keywords, such as print, goto, and return have special significance for the GW-BASIC Interpreter. GW-BASIC interprets keywords as part of statements or commands.

Statements, Functions, Commands, and Variables

Keywords are also called reserved words. They cannot be used as variable names, or the system will interpret them as commands. However, keywords may be embedded within variable names.

Keywords are stored in the system as tokens (1- or 2-byte characters) for the most efficient use of memory space.

## 2.4.2 Commands

Commands and statements are both executable instructions. The difference between commands and statements is that commands are generally executed in the direct mode, or command level of the interpreter. They usually perform some type of program maintenance such as editing, loading, or saving programs. When GW-BASIC is invoked and the GW-BASIC prompt, `Ok`, appears, the system assumes command level.

## 2.4.3 Statements

A statement, such as `ON ERROR...GOTO`, is a group of GW-BASIC keywords generally used in GW-BASIC program lines as part of a program. When the program is run, statements are executed when, and as, they appear.

## 2.4.4 Functions

The GW-BASIC Interpreter performs both numeric and string functions.

### 2.4.4.1 Numeric Functions

The GW-BASIC Interpreter can perform certain mathematical (arithmetical or algebraic) calculations. For example, it calculates the sine (`sin`), cosine (`cos`), or tangent (`tan`) of angle `x`.

Unless otherwise indicated, only integer and single-precision results are returned by numeric functions.

### 2.4.4.2 String Functions

String functions operate on strings. For example, `TIMES` and `DATES` return the time and date known by the system. If the current time and date are entered during system start up, the correct time and date are given (the internal clock in the computer keeps track).

### 2.4.4.3 User-Defined Functions

Functions can be user-defined by means of the `DEF FN` statement. These functions can be either string or numeric.

## 2.4.5 Variables

Certain groups of alphanumeric characters are assigned values and are called variables. When variables are built into the GW-BASIC program they provide information as they are executed.

For example, `ERR` defines the latest error which occurred in the program; `ERL` gives the location of that error. Variables can also be defined and/or

redefined by the user or by program content.

All GW-BASIC commands, statements, functions, and variables are individually described in the GW-BASIC User's Reference.

## 2.5 Line Format

Each of the elements of GW-BASIC can make up sections of a program that are called statements. These statements are very similar to sentences in English. Statements are then put together in a logical manner to create programs. The GW-BASIC User's Reference describes all of the statements available for use in GW-BASIC.

In a GW-BASIC program, lines have the following format:

nnnnn statement[statements]

nnnnn is a line number

statement is a GW-BASIC statement.

Statements, Functions, Commands, and Variables

A GW-BASIC program line always begins with a line number and must contain at least one character, but no more than 255 characters. Line numbers indicate the order in which the program lines are stored in memory, and are also used as references when branching and editing. The program line ends when you press the RETURN key.

Depending on the logic of your program, there may be more than one statement on a line. If so, each must be separated by a colon (:). Each of the lines in a program should be preceded by a line number. This number may be any whole integer from 0 to 65529. It is customary to use line numbers such as 10, 20, 30, and 40, in order to leave room for any additional lines that you may wish to include later. Since the computer will run the statements in numerical order, additional lines needn't appear in consecutive order on the screen: for example, if you entered line 35 after line 60, the computer would still run line 35 after line 30 and before line 40. This technique may save your reentering an entire program in order to include one line that you have forgotten.

The width of your screen is 80 characters. If your statement exceeds this width, the cursor will wrap to the next screen line automatically. Only when you press the RETURN key will the computer acknowledge the end of the line. Resist the temptation to press RETURN as you approach the edge of the screen (or beyond). The computer will automatically wrap the line for you. You can also press CTRL-RETURN, which causes the cursor to move to the beginning of the next screen line without actually entering the line. When you press RETURN, the entire logical line is passed to GW-BASIC for storage in the program.

In GW-BASIC, any line of text that begins with a numeric character is considered a program line and is processed in one of three ways after the RETURN key is pressed:

- o A new line is added to the program. This occurs if the line number is legal (within the range of 0 through 65529), and if at least one alpha or special character follows the line number in the line.
- o An existing line is modified. This occurs if the line number matches the line number of an existing line in the program. The existing line is replaced with the text of the newly-entered line. This process is called editing.

#### Note

Reuse of an existing line number causes all of the information contained in the original line to be lost. Be careful when entering numbers in the indirect mode. You may erase some program lines by accident.

- o An existing line is deleted. This occurs if the line number matches the line number of an existing line, and the entered line contains only a line number. If an attempt is made to delete a nonexistent line, an "Undefined line number" error message is displayed.

## 2.6 Returning to MS-DOS

Before you return to MS-DOS, you must save the work you have entered under GW-BASIC, or the work will be lost.

To return to MS-DOS, type the following after the Ok prompt, and press RETURN:  
system

The system returns to MS-DOS, and the A> prompt appears on your screen.

## 3 Reviewing and Practicing GW-BASIC

### Example for the Direct Mode

The practice sessions in this chapter will help you review what you have learned. If you have not done so, this is a good time to turn on your computer and load the GW-BASIC Interpreter.

### 3.1 Example for the Direct Mode

You can use your computer in the direct mode to perform fundamental arithmetic operations. GW-BASIC recognizes the following symbols as arithmetic operators:

| Operation      | GW-BASIC Operator |
|----------------|-------------------|
| Addition       | +                 |
| Subtraction    | -                 |
| Multiplication | *                 |
| Division       | /                 |

To enter a problem, respond to the Ok prompt with a question mark (?), followed by the statement of the problem you want to solve, and press the RETURN key. In GW-BASIC, the question mark can be used interchangeably with the keyword PRINT. The answer is then displayed.

Type the following and press the RETURN key:

```
?2+2
```

GW-BASIC will display the answer on your screen:

```
?2+2
4
Ok
```

To practice other arithmetic operations, replace the + sign with the desired operator.

The GW-BASIC language is not restricted to arithmetic functions. You can also enter complex algebraic and trigonometric functions. The formats for these functions are provided in Chapter 6, "Constants, Variables, Expressions and Operators."

## 3.2 Examples for the Indirect Mode

The GW-BASIC language can be used for functions other than simple algebraic calculations. You can create a program that performs a series of operations and then displays the answer. To begin programming, you create lines of instructions called statements. Remember that there can be more than one statement on a line, and that each line is preceded by a number.

For example, to create the command PRINT 2+3 as a statement, type the following:

```
10 print 2+3
```

When you press the RETURN key, the cursor shifts to the next line, but nothing else happens. To make the computer perform the calculation, type the following and press the RETURN key:

```
run
```

Your screen should look like this:

```
Ok
```

```
10 print 2+3
run
5
Ok
```

You have just written a program in GW-BASIC.

The computer reserves its calculation until specifically commanded to continue (with the RUN command). This allows you to enter more lines of instruction. When you type the RUN command, the computer does the addition and displays the answer.

The following program has two lines of instructions. Type it in:

```
10 x=3
20 print 2+x
```

Now use the RUN command to have the computer calculate the answer.

Examples for the Indirect Mode

Your screen should look like this:

```
Ok
10 x=3
20 print 2+x
run
5
Ok
```

The two features that distinguish a program from a calculation are

1. the numbered lines
2. the use of the RUN command

These features let the computer know that all the statements have been typed and the computation can be carried out from beginning to end. It is the numbering of the lines that first signals the computer that this is a program, not a calculation, and that it must not do the actual computation until the RUN command is entered.

In other words, calculations are done under the direct mode. Programs are written under the indirect mode.

To display the entire program again, type the LIST command and press the RETURN key:

```
list
```

Your screen should look like this:

```
Ok
10 x=3
20 print 2+x
run
Ok
```



```
5
Ok
list
10 X=3
20 PRINT 2+X
Ok
```

You'll notice a slight change in the program. The lowercase letters you entered have been converted into uppercase letters. The LIST command makes this change automatically.

## 3.3 Function Keys

Function keys are keys that have been assigned to frequently-used commands. The ten function keys are located on the left side of your keyboard. A guide to these keys and their assigned commands appears on the bottom of the GW-BASIC screen. To save time and keystrokes, you can press a function key instead of typing a command name.

For example, to list your program again, you needn't type the LIST command; you can use the function key assign to it, instead:

- o Press the F1 key.
- o Press RETURN.

Your program should appear on the screen.

To run the program, simply press the F2 key, which is assigned to the RUN command.

As you learn more commands, you'll learn how to use keys F3 through F10. Chapter 4, "The GW-BASIC Screen Editor," contains more information about keys used in GW-BASIC.

## 3.4 Editing Lines

There are two basic ways to change lines. You can

- o Delete and replace them
- o Alter them with the EDIT command

To delete a line, simply type the line number and press the RETURN key. For example, if you type 12 and press the RETURN key, line number 12 is deleted from your program.

To use the EDIT command, type the command EDIT, followed by the number of the line you want to change. For example, type the following, and press the RETURN key:

```
edit 10
```

Saving your Program File

You can then use the following keys to perform editing:

#### Key Function

CURSOR UP Moves the cursor within the statement

CURSOR DOWN

CURSOR LEFT

CURSOR RIGHT

BACKSPACE Deletes the character to the left of the cursor

DELETE (DEL) Deletes the current character

INSERT (INS) Lets you insert characters to the left of the cursor.

For example, to modify statement (line) 10 to read `x=4`, use the cursor-right control key to move the cursor under the 3, and then type a 4. The number 4 replaces the number 3 in the statement.

Now press the RETURN key, and then the F2 key.

Your screen displays the following:

```
Ok
10 X=4
RUN
  6
Ok
```

## 3.5 Saving Your Program File

Creating a program is like creating a data file. The program is a file that contains specific instructions, or statements, for the computer. In order to use the program again, you must save it, just as you would a data file.

To save a file in GW-BASIC, use the following procedure:

1. Press the F4 key.

The command word `SAVE` appears on your screen.

2. Type a name for the program, and press the RETURN key. The file is saved under the name you specified.

To recall a saved file, use the following procedure:

1. Press the F3 key.

The command word `LOAD` appears on your screen.

2. Type the name of the file.
3. Press RETURN.

The file is loaded into memory, and ready for you to list, edit, or run.

# 4 The GW-BASIC Screen Editor

## Editing Lines in Saved Files

You can edit GW-BASIC program lines as you enter them, or after they have been saved in a program file.

### 4.1 Editing Lines in New Files

If an incorrect character is entered as a line is being typed, it can be Deleted with the BACKSPACE or DEL keys, or with CTRL-H. After the character is deleted, you can continue to type on the line.

The ESC key lets you delete a line from the screen that is in the process of being typed. In other words, if you have not pressed the RETURN key, and you wish to delete the current line of entry, press the ESC key.

To delete the entire program currently residing in memory, enter the NEW command. NEW is usually used to clear memory prior to entering a new program.

### 4.2 Editing Lines in Saved Files

After you have entered your GW-BASIC program and saved it, you may discover that you need to make some changes. To make these modifications, use the LIST statement to display the program lines that are affected:

1. Reload the program
2. Type the LIST command, or press the F1 key.
3. Type the line number, or range of numbers, to be edited.

The lines will appear on your screen.

#### 4.2.1 Editing the Information in a Program Line

You can make changes to the information in a line by positioning the cursor where the change is to be made, and by doing one of the following:

- o Typing over the characters that are already there.
- o Deleting characters to the left of the cursor, using the BACKSPACE key.
- o Deleting characters at the cursor position using the DEL key on the number pad.
- o Inserting characters at the cursor position by pressing the INS key on the number pad. This moves the characters following the cursor to the right making room for the new information.

- o Adding to or truncating characters at the end of the program line.

If you have changed more than one line, be sure to press RETURN on each modified line. The modified lines will be stored in the proper numerical sequence, even if the lines are not updated in numerical order.

#### Note

A program line will not actually have changes recorded within the GW-BASIC program until the RETURN key is pressed with the cursor positioned somewhere on the edited line.

You do not have to move the cursor to the end of the line before pressing the RETURN key. The GW-BASIC Interpreter remembers where each line ends, and transfers the whole line, even if RETURN is pressed while the cursor is located in the middle or at the beginning of the line.

To truncate, or cut off, a line at the current cursor position, type CTRL-END or CTRL-E, followed by pressing the RETURN key.

If you have originally saved your program to a program file, make sure that you save the edited version of your program. If you do not do this, your modifications will not be recorded.

## 4.3 Special Keys

The GW-BASIC Interpreter recognizes nine of the numeric keys on the right side of your keyboard. It also recognizes the BACKSPACE key, ESC key, and the CTRL key. The following keys and key sequences have special functions in GW-BASIC:

**BACKSPACE or CTRL-H** Deletes the last character typed, or deletes the character to the left of the cursor. All characters to the right of the cursor are moved left one position. Subsequent characters and lines within the current logical line are moved up as with the DEL key.

**CTRL-BREAK or CTRL-C** Returns to the direct mode, without saving changes made to the current line. It will also exit auto line-numbering mode.

**CTRL-CURSOR-LEFT or CTRL-B** Moves the cursor to the beginning of the previous word. The previous word is defined as the next character to the left of the cursor in the set A to Z or in the set 0 to 9.

**CTRL-CURSOR-RIGHT or CTRL-F** Moves the cursor to the beginning of the next word. The next word is defined as the next character to the right of the cursor in the set A to Z or in the set 0 to 9. In other words, the cursor moves to the next number or letter after a blank or other special character.

**CURSOR-DOWN or CTRL** Moves the cursor down one line on the screen.

**CURSOR-LEFT or CTRL-]** Moves the cursor one position left. When the cursor is advanced beyond the left edge of the screen, it will wrap to the right side of the screen on the preceding line.

**CURSOR-RIGHT or CTRL-\** Moves the cursor one position right. When the cursor is advanced beyond the right edge of the screen, it will wrap to the left side of the screen on the following line.

CURSOR-UP or CTRL-6 Moves the cursor up one line on the screen.

CTRL-BACKSPACE or DEL Deletes the character positioned over the cursor. All characters to the right of the one deleted are then moved one position left to fill in where the deletion was made.

If a logical line extends beyond one physical line, characters on subsequent lines are moved left one position to fill in the previous space, and the character in the first column of each subsequent line is moved up to the end of the preceding line.

DEL (delete) is the opposite of INS (insert). Deleting text reduces logical line length.

CTRL-END or CTRL-E Erases from the cursor position to the end of the logical line. All physical screen lines are erased until the terminating RETURN is found.

CTRL-N or END Moves the cursor to the end of the logical line. Characters typed from this position are added to the line.

CTRL-RETURN or CTRL-J Moves the cursor to the beginning of the next screen line. This lets you create logical program lines which are longer than the physical screen width. Logical lines may be up to 255 characters long. This function may also be used as a line feed.

CTRL-M or RETURN Enters a line into the GW-BASIC program. It also moves the cursor to the next logical line.

CTRL-[ or ESC Erases the entire logical line on which the cursor is located.

CTRL-G Causes a beep to emit from your computer's speaker.

CTRL-K or HOME Moves the cursor to the upper left corner of the screen. The screen contents are unchanged.

CTRL-HOME or CTRL-L Clears the screen and positions the cursor in the upper left corner of the screen.

CTRL-R or INS Turns the Insert Mode on and off. Insert Mode is indicated by the cursor blotting the lower half of the character position. In Graphics Mode, the normal cursor covers the whole character position. When Insert Mode is active, only the lower half of the character position is blanked by the cursor.

When Insert Mode is off, characters typed replace existing characters on the line. The SPACEBAR erases the character at the current cursor position and moves the cursor one character to the right. The CURSOR-RIGHT key moves the cursor one character to the right, but does not delete the character.

When Insert Mode is off, pressing the TAB key moves the cursor over characters until the next tab stop is reached. Tab stops occur every eight character positions.

When Insert Mode is on, characters following the cursor are moved to the right as typed characters are inserted before them at the current cursor position.

After each keystroke, the cursor moves one position to the right. Line wrapping is observed. That is, as characters move off the right side of the screen, they are inserted from the left on subsequent lines. Insertions increase logical line length.

When Insert Mode is on, pressing the TAB key causes blanks to be inserted from current cursor position to the next tab stop. Line wrapping is observed as above.

CTRL-NUM LOCK or CTRL-S Places the computer in a pause state. To resume operation, press any other key.

CTRL-PRTSC Causes characters printed on the screen to echo to the lineprinter (lpt1:). In other words, you will be printing what you type on the screen. Pressing CTRL-PRTSC a second time turns off the echoing of characters to lpt1:.

SHIFT + PRTSC Sends the current screen contents to the printer, effectively creating a snapshot of the screen.

CTRL-I or TAB Moves the cursor to the next tab stop. Tab stops occur every eight columns.

## 4.4 Function Keys

Certain keys or combinations of keys let you perform frequently-used commands or functions with a minimum number of keystrokes. These keys are called function keys.

The special function keys that appear on the left side of your keyboard can be temporarily redefined to meet the programming requirements and specific functions that your program may require.

Function keys allow rapid entry of as many as 15 characters into a program with one keystroke. These keys are located on the left side of your keyboard and are labelled F1 through F10. GW-BASIC has already assigned special functions to each of these keys. You will notice that after you load GW-BASIC, these special key functions appear on the bottom line of your screen. These key assignments have been selected for you as some of the most frequently used commands.

Initially, the function keys are assigned the following special functions:

Table 4.1: GW-BASIC Function Key Assignments

| Key | Function | Key | Function         |
|-----|----------|-----|------------------|
| F1  | LIST     | F6  | , "LPT1: "<-     |
| F2  | RUN<-    | F7  | TRON<-           |
| F3  | LOAD"    | F8  | TROFF<-          |
| F4  | SAVE"    | F9  | KEY              |
| F5  | CONT<-   | F10 | SCREEN 0, 0, 0<- |

#### Note

The <- following a function indicates that you needn't press the RETURN key after the function key. The selected command will be immediately executed.

If you choose, you may change the assignments of these keys. Any one or all of the 10 function keys may be redefined. For more information, see the KEY and ON KEY statements in the GW-BASIC User's Reference.

## 5 Creating and Using Files

There are two types of files in MS-DOS systems:

- o Program files, which contain the program or instructions for the computer
- o Data files, which contain information used or created by program files

### 5.1 Program File Commands

The following are the commands and statements most frequently used with program files. The GW-BASIC User's Reference contains more information on each of them.

SAVE filename[, a][, p]

Writes to diskette the program currently residing in memory.

LOAD filename[, r]

Loads the program from a diskette into memory. LOAD deletes the current contents of memory and closes all files before loading the program.

RUN filename[, r]

Loads the program from a diskette into memory and runs it immediately. RUN deletes the current contents of memory and closes all files before loading the program.

MERGE filename

Loads the program from a diskette into memory, but does not delete the current program already in memory.

KILL filename

Deletes the file from a diskette. This command can also be used with data files.

NAME old filename AS new filename

Changes the name of a diskette file. Only the name of the file is changed. The file is not modified, and it remains in the same space and position on the disk. This command can also be used with data files.

## 5.2 Data Files

GW-BASIC programs can work with two types of data files:

- o Sequential files
- o Random access files

Sequential files are easier to create than random access files, but are limited in flexibility and speed when accessing data. Data written to a sequential file is a series of ASCII characters. Data is stored, one item after another (sequentially), in the order sent. Data is read back in the same way.

Creating and accessing random access files requires more program steps than sequential files, but random files require less room on the disk, because GW-BASIC stores them in a compressed format in the form of a string.

The following sections discuss how to create and use these two types of data files.

### 5.2.1 Creating a Sequential File

The following statements and functions are used with sequential files:

CLOSE LOF  
EOF OPEN  
INPUT# PRINT#  
LINE INPUT# PRINT# USING  
LOC UNLOCK  
LOCK WRITE#

The following program steps are required to create a sequential file and access the data in the file:

1. Open the file in output (0) mode. The current program will use this file first for output:

OPEN "0", #1, "filename"

2. Write data to the file using the PRINT# or WRITE# statement:

PRINT#1, AS



```
PRINT#1, BS
PRINT#1, CS
```

3. To access the data in the file, you must close the file and reopen it in input (I) mode:

```
CLOSE #1
OPEN "I", #1, "filename"
```

4. Use the INPUT# or LINE INPUT# statement to read data from the sequential file into the program:

```
INPUT#1, XS, YS, ZS
```

Example 1 is a short program that creates a sequential file, data, from information input at the terminal.

#### Example 1

```
10 OPEN "O", #1, "DATA"
20 INPUT "NAME"; NS
30 IF NS="DONE" THEN END
40 INPUT "DEPARTMENT"; DS
50 INPUT "DATE HIRED"; HS
60 PRINT#1, NS; ", ", "DS", ", "; HS
70 PRINT: GOTO 20
RUN
NAME? MICKEY MOUSE
DEPARTMENT? AUDIO/VISUAL AIDS
DATE HIRED? 01/12/72

NAME? SHERLOCK HOLMES
DEPARTMENT? RESEARCH
DATE HIRED? 12/03/65

NAME? EBENEZER SCROOGE
DEPARTMENT? ACCOUNTING
DATE HIRED? 04/27/78

NAME? SUPER MANN
DEPARTMENT? MAINTENANCE
DATE HIRED? 08/16/78

NAME? DONE
OK
```

## 5.2.2 Accessing a Sequential File

The program in Example 2 accesses the file data, created in the program in Example 1, and displays the name of everyone hired in 1978.

### Example 2

```
10 OPEN "I", #1, "DATA"
20 INPUT#1, N$, D$, H$
30 IF RIGHT$(H$, 2) = "78" THEN PRINT N$
40 GOTO 20
50 CLOSE #1
RUN
EBENEEZER SCROOGE
SUPER MANN
Input past end in 20
Ok
```

The program in Example 2 reads, sequentially, every item in the file. When all the data has been read, line 20 causes an "Input past end" error. To avoid this error, insert line 15, which uses the EOF function to test for end of file:

```
15 IF EOF(1) THEN END
```

and change line 40 to GOTO 15.

A program that creates a sequential file can also write formatted data to the diskette with the PRINT# USING statement. For example, the following statement could be used to write numeric data to diskette without explicit delimiters:

```
PRINT#1, USING"####. ##, "; A, B, C, D
```

The comma at the end of the format string serves to separate the items in the disk file.

The LOC function, when used with a sequential file, returns the number of 128-byte records that have been written to or read from the file since it was opened.

## 5.2.3 Adding Data to a Sequential File

When a sequential file is opened in 0 mode, the current contents are destroyed. To add data to an existing file without destroying its contents, open the file in append (A) mode.

The program in Example 3 can be used to create, or to add onto a file called names. This program illustrates the use of LINE INPUT. LINE INPUT will read in characters until it sees a carriage return indicator, or until it has read 255 characters. It does not stop at quotation marks or commas.

### Example 3

```
10 ON ERROR GOTO 2000
20 OPEN "A", #1, "NAMES"
110 REM ADD NEW ENTRIES TO FILE
120 INPUT "NAME"; N$
130 IF N$="" THEN 200 `CARRIAGE RETURN EXITS INPUT LOOP
140 LINE INPUT "ADDRESS? "; A$
150 LINE INPUT "BIRTHDAY? "; B$
160 PRINT#1, N$
170 PRINT#1, A$
180 PRINT#1, B$
190 PRINT: GOTO 120
200 CLOSE #1
2000 ON ERROR GOTO 0
```

In lines 10 and 2000 the ON ERROR GOTO statement is being used. This statement enables error trapping and specifies the first line (2000) of the error handling subroutine. Line 10 enables the error handling routine. Line 2000 disables the error handling routine and is the point where GW-BASIC branches to print the error messages.

## 5.3 Random Access Files

Information in random access files is stored and accessed in distinct, numbered units called records. Since the information is called by number, the data can be called from any disk location; the program needn't read the entire disk, as when seeking sequential files, to locate data. GW-BASIC supports large random files. The maximum logical record number is 2 32 -1.

The following statements and functions are used with random files:

```
CLOSE FIELD MKI$
CVD LOC MKS$
CVI LOCK OPEN
CVS LOF PUT
EOF LSET/RSET UNLOCK
ET MKD$
```

### 5.3.1 Creating a Random Access File

The following program steps are required to create a random data file:

1. Open the file for random access (R) mode. The following example specifies a record length of 32 bytes. If the record length is omitted, the default is 128 bytes.

```
OPEN "R", #1, "filename", 32
```

2. Use the FIELD statement to allocate space in the random buffer for the variables that will be written to the random file:

```
FIELD#1, 20 AS N$, 4 AS A$, 8 AS P$
```

In this example, the first 20 positions (bytes) in the random file buffer are allocated to the string variable N\$. The next 4 positions are allocated to A\$; the next 8 to P\$.

3. Use LSET or RSET to move the data into the random buffer fields in left- or right-justified format (L=left SET; R=right SET). Numeric values must be made into strings when placed in the buffer. MKI\$ converts an integer value into a string; MKS\$ converts a single-precision value, and MKD\$ converts a double-precision value.

```
LSET N$=X$
LSET A$=MK$$(AMT)
LSET P$=TELS
```

4. Write the data from the buffer to the diskette using the PUT statement:

```
PUT #1, CODE%
```

The program in Example 4 takes information keyed as input at the terminal and writes it to a random access data file. Each time the PUT statement is executed, a record is written to the file. In the example, the 2-digit CODE% input in line 30 becomes the record number.

#### Note

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.

#### Example 4

```
10 OPEN "R", #1, "INFOFILE", 32
20 FIELD#1, 20 AS N$, 4 AS A$, 8 AS P$
30 INPUT "2-DIGIT CODE"; CODE%
40 INPUT "NAME"; X$
50 INPUT "AMOUNT"; AMT
60 INPUT "PHONE"; TELS: PRINT
70 LSET N$=X$
80 LSET A$=MK$$(AMT)
90 LSET P$=TELS
100 PUT #1, CODE%
110 GOTO 30
```

### 5.3.2 Accessing a Random Access File

The following program steps are required to access a random file:

1. Open the file in R mode:

```
OPEN "R", #1, "filename", 32
```

2. Use the FIELD statement to allocate space in the random buffer for the variables that will be read from the file:

```
FIELD, #1, 20 AS N$, 4 AS A$, 8 AS P$
```

In this example, the first 20 positions (bytes) in the random file buffer are allocated to the string variable N\$. The next 4 positions are allocated to A\$; the next 8 to 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.

3. Use the GET statement to move the desired record into the random buffer.

```
GET #1, CODE%
```

The data in the buffer can now be accessed by the program.

4. Convert numeric values back to numbers using the convert functions: CVI for integers, CVS for single-precision values, and CVD for double-precision values.

```
PRINT N$  
PRINT CVS(A$)
```

```
.  
. .  
.
```

The program in Example 5 accesses the random file, infofile, that was created in Example 4. By inputting the 3-digit code, the information associated with that code is read from the file and displayed.

#### Example 5

```
10 OPEN "R", #1, "INFOFILE", 32  
20 FIELD #1, 20 AS N$, 4 AS A$, 8 AS P$  
30 INPUT "2-DIGIT CODE"; CODE%  
40 GET #1, CODE%  
50 PRINT N$  
60 PRINT USING "$$###. ##"; CVS(A$)  
70 PRINT P$: PRINT  
80 GOTO 30
```

With random files, the LOC function returns the current record number. The current record number is the last record number used in a GET or PUT statement. For example, the following line ends program execution if the current record number in file#1 is higher than 99:

```
IF LOC(1)>99 THEN END
```

Example 6 is an inventory program that illustrates random file access. In this program, the record number is used as the part number, and it is assumed that the inventory will contain no more than 100 different part numbers.

Lines 900-960 initialize the data file by writing CHR\$(255) as the first character of each record. This is used later (line 270 and line 500) to determine whether an entry already exists for that part number.

Lines 130-220 display the different inventory functions that the program performs. When you type in the desired function number, line 230 branches to the appropriate subroutine.

#### Example 6

```
120 OPEN"R", #1, "INVEN. DAT", 39
125 FIELD#1, 1 AS F$, 30 AS D$, 2 AS Q$, 2 AS R$, 4 AS P$
130 PRINT: PRINT "FUNCTIONS: ": PRINT
135 PRINT 1, "INITIALIZE FILE"
140 PRINT 2, "CREATE A NEW ENTRY"
150 PRINT 3, "DISPLAY INVENTORY FOR ONE PART"
160 PRINT 4, "ADD TO STOCK"
170 PRINT 5, "SUBTRACT FROM STOCK"
180 PRINT 6, "DISPLAY ALL ITEMS BELOW REORDER LEVEL"
220 PRINT: PRINT: INPUT"FUNCTION"; FUNCTION
225 IF (FUNCTION<1)OR(FUNCTION>6) THEN PRINT "BAD FUNCTION
NUMBER": GOTO 130
230 ON FUNCTION GOSUB 900, 250, 390, 480, 560, 680
240 GOTO 220
250 REM BUILD NEW ENTRY
260 GOSUB 840
270 IF ASC(F$) < > 255 THEN INPUT"OVERWRITE"; AS:
  IF AS < > "Y" THEN RETURN
280 LSET F$=CHR$(0)
290 INPUT "DESCRIPTION"; DESC$
300 LSET D$=DESC$
310 INPUT "QUANTITY IN STOCK"; Q%
320 LSET Q$=MKI$(Q%)
330 INPUT "REORDER LEVEL"; R%
340 LSET R$=MKI$(R%)
350 INPUT "UNIT PRICE"; P
360 LSET P$=MK$(P)
370 PUT#1, PART%
380 RETURN
390 REM DISPLAY ENTRY
400 GOSUB 840
410 IF ASC(F$)=255 THEN PRINT "NULL ENTRY": RETURN
420 PRINT USING "PART NUMBER ###"; PART%
430 PRINT D$
440 PRINT USING "QUANTITY ON HAND #####"; CVI(Q$)
```

```

450 PRINT USING "REORDER LEVEL #####"; CVI(R$)
460 PRINT USING "UNIT PRICE $$#. ##"; CVS(P$)
470 RETURN
480 REM ADD TO STOCK
490 GOSUB 840
500 IF ASC(F$)=255 THEN PRINT "NULL ENTRY": RETURN
510 PRINT D$: INPUT "QUANTITY TO ADD"; A%
520 Q%=CVI(Q$)+A%
530 LSET Q$=MKI$(Q%)
540 PUT#1, PART%
550 RETURN
560 REM REMOVE FROM STOCK
570 GOSUB 840
580 IF ASC(F$)=255 THEN PRINT "NULL ENTRY": RETURN
590 PRINT D$
600 INPUT "QUANTITY TO SUBTRACT"; S%
610 Q%=CVI(Q$)
620 IF (Q%-S%)<0 THEN PRINT "ONLY"; Q%; " IN STOCK" : GOTO 600
630 Q%=Q%-S%
640 IF Q%= < CVI(R$) THEN PRINT "QUANTITY NOW"; Q%;
"REORDER LEVEL"; CVI(R$)
650 LSET Q$=MKI$(Q%)
660 PUT#1, PART%
670 RETURN
680 REM DISPLAY ITEMS BELOW REORDER LEVEL4
690 FOR I=1 TO 100
710 GET#1, I
720 IF CVI(Q$)<CVI(R$) THEN PRINT D$; " QUANTITY";
CVI(Q$) TAB(50) "REORDER LEVEL"; CVI(R$)
730 NEXT I
740 RETURN
840 INPUT "PART NUMBER"; PART%
850 IF(PART% < 1)OR(PART% > 100) THEN PRINT "BAD PART NUMBER":
GOTO 840 ELSE GET#1, PART%: RETURN
890 END
900 REM INITIALIZE FILE
910 INPUT "ARE YOU SURE"; BS: IF BS < > "Y" THEN RETURN
920 LSET F$=CHR$(255)
930 FOR I=1 TO 100
940 PUT#1, I
950 NEXT I
960 RETURN

```

## 6 Constants, Variables, Expressions and Operators

After you have learned the fundamentals of programming in GW-BASIC, you will find that you will want to write more complex programs. The information in this chapter will help you learn more about the use of constants, variables, expressions, and operators in GW-BASIC, and how they can be used to develop more sophisticated programs.

## 6.1 Constants

Constants are static values the GW-BASIC Interpreter uses during execution of your program. There are two types of constants: string and numeric.

A string constant is a sequence of 0 to 255 alphanumeric characters enclosed in double quotation marks. The following are sample string constants:

"HELLO"

"\$25,000.00"

"Number of Employees"

Numeric constants can be positive or negative. When entering a numeric constant in GW-BASIC, you should not type the commas. For instance, if the number 10,000 were to be entered as a constant, it would be typed as 10000. There are five types of numeric constants: integer, fixed-point, floating-point, hexadecimal, and octal.

| Constant       | Description  |
|----------------|--|
| Integer        | Whole numbers between -32768 and +32767. They do not contain Decimal points.   |
| Fixed-Point    | Positive or negative real numbers that contain decimal points.   |
| Floating-Point | Positive or negative numbers represented in exponential form (similar to scientific notation).<br>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).<br><br>The allowable range for floating-point constants is 3.0X10 <sup>-39</sup> to 1.7X10 <sup>38</sup> .<br><br>For example:<br><br>235.988E-7=.0000235988<br>2359E6=2359000000 |
| Hexadecimal    | Hexadecimal numbers with prefix &H. For example:<br><br>&H76<br>&H32F  |
| Octal          | Octal numbers with the prefix &O or &. For example:<br><br>&O347<br>&1234  |

### 6.1.1 Single- and Double-Precision Form for Numeric Constants

Numeric constants can be either integers, single-precision or double-precision numbers. Integer constants are stored as whole numbers only. Single-precision numeric constants are stored with 7 digits (although only 6 may be accurate). Double-precision numeric constants are stored with 17 digits of precision, and



printed with as many as 16 digits.

A single-precision constant is any numeric constant with either

- o Seven or fewer digits
- o Exponential form using E
- o A trailing exclamation point (!)

A double-precision constant is any numeric constant with either

- o Eight or more digits
- o Exponential form using D
- o A trailing number sign (#)

The following are examples of single- and double-precision numeric constants:

| Single-Precision Constants | Double-Precision Constants |
|----------------------------|----------------------------|
| 46.8                       | 345692811                  |
| -1.09E-06                  | -1.09432D-06               |
| 3489.0                     | 3490.0#                    |
| 22.5!                      | 7654321.1234               |

## 6.2 Variables

Variables are the names that you have chosen to represent values used in a GW-BASIC program. The value of a variable may be assigned specifically, or may be the result of calculations in your program. If a variable is assigned no value, GW-BASIC assumes the variable's value to be zero.

### 6.2.1 Variable Names and Declarations

GW-BASIC variable names may be any length; up to 40 characters are significant. The characters allowed in a variable name are letters, numbers, and the decimal point. The first character in the variable name must be a letter. Special type declaration characters are also allowed.

Reserved words (all the words used as GW-BASIC commands, statements, functions, and operators) can't be used as variable names. However, if the reserved word is embedded within the variable name, it will be allowed.

Variables may represent either numeric values or strings.

## 6.2.2 Type Declaration Characters

Type declaration characters indicate what a variable represents. The following type declaration characters are recognized:

|                             |
|-----------------------------|
| \$ String variable          |
| % Integer variable          |
| ! Single-precision variable |
| # Double-precision variable |

The following are sample variable names for each type:

| Variable Type             | Sample Name |
|---------------------------|-------------|
| String variable           | N\$         |
| Integer variable          | LIMIT%      |
| Single-precision variable | MINIMUM!    |
| Double-precision variable | PI#         |

The default type for a numeric variable name is single-precision. Double-precision, while very accurate, uses more memory space and more calculation time. Single-precision is sufficiently accurate for most applications. However, the seventh significant digit (if printed) will not always be accurate. You should be very careful when making conversions between integer, single-precision, and double-precision variables.

The following variable is a single-precision value by default:

ABC

Variables beginning with FN are assumed to be calls to a user-defined function.

The GW-BASIC statements DEFINT, DEFSTR, DEFSNG, and DEFDBL may be included in a program to declare the types of values for certain variable names.

## 6.2.3 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 a subscripted integer or an integer expression. The subscript is enclosed within parentheses. An array variable name has as many subscripts as there are dimensions in the array.

For example,

V(10)

references a value in a one-dimensional array, while

T(1, 4)

references a value in a two-dimensional array.

The maximum number of dimensions for an array in GW-BASIC is 255. The maximum number of elements per dimension is 32767.

#### Note

If you are using an array with a subscript value greater than 10, you should use the DIM statement. Refer to the GW-BASIC User's Reference for more information. If a subscript greater than the maximum specified is used, you will receive the error message "Subscript out of range."

Multidimensional arrays (more than one subscript separated by commas) are useful for storing tabular data. For example, A(1,4) could be used to represent a two-row, five-column array such as the following:

Column 0 1 2 3 4

Row 0 10 20 30 40 50  
Row 1 60 70 80 90 100

In this example, element A(1,2)=80 and A(0,3)=40.

Rows and columns begin with 0, not 1, unless otherwise declared. For more information, see the OPTION BASE statement in the GW-BASIC User's Reference.

## 6.2.4 Memory Space Requirements for Variable Storage

The different types of variables require different amounts of storage. Depending on the storage and memory capacity of your computer and the size of the program that you are developing, these can be important considerations.

| Variable Type          | Required Bytes of Storage   |
|------------------------|---|
| Integer                | 2   |
| Single-precision       | 4   |
| Double-precision       | 8   |
| Integer array          | 2 per element   |
| Single-precision array | 4 per element   |
| Double-precision array | 8 per element   |
| Strings                | Three bytes overhead, plus the present contents of the string as one byte for each character in the string. Quotation marks marking the beginning and end of each string are not counted. |

## 6.3 Type Conversion

When necessary, GW-BASIC converts a numeric constant from one type of variable to another, according to the following rules:

- o If a numeric constant of one type is set equal to a numeric variable of a different type, the number is stored as the type declared in the variable name. For example:

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

If a string variable is set equal to a numeric value or vice versa, a "Type Mismatch" error occurs.

- o During an expression evaluation, all of the operands in an arithmetic or relational operation are converted to the same degree of precision; that is, that of the most precise operand. Also, the result of an arithmetic operation is returned to this degree of precision. For example:

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

The arithmetic is performed in double-precision, and the result is returned in D# as a double-precision value.

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

The arithmetic is performed in double-precision, and the result is returned to D (single-precision variable) rounded and printed as a single-precision value.

- o Logical operators convert their operands to integers and return an integer result. Operands must be within the range of -32768 to 32767 or an "Overflow" error occurs.
- o When a floating-point value is converted to an integer, the fractional portion is rounded.

For example:

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

- o If a double-precision variable is assigned a single-precision value, only the first seven digits (rounded), of the converted number are valid. This is because only seven digits of accuracy were supplied with the single-precision value. The absolute value of the difference between the printed double-precision number, and the original single-precision value, is less

than 6.3E-8 times the original single-precision value.

For example:

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

## 6.4 Expressions and Operators

An expression may be simply a string or numeric constant, 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 GW-BASIC are divided into four categories:

- o Arithmetic
- o Relational
- o Logical
- o Functional

### 6.4.1 Arithmetic Operators

The following are the arithmetic operators recognized by GW-BASIC. They appear in order of precedence.

| Operator | Operation               |
|----------|-------------------------|
| ^        | Exponentiation          |
| -        | Negation                |
| *        | Multiplication          |
| /        | Floating-point Division |
| +        | Addition                |
| -        | Subtraction             |

Operations within parentheses are performed first. Inside the parentheses, the usual order of precedence is maintained.

The following are sample algebraic expressions and their GW-BASIC counterparts:

| Algebraic Expression | BASIC Expression |
|----------------------|------------------|
| $X - Z / Y$          | $(X - Y) / Z$    |
| $XY / Z$             | $X * Y / Z$      |
| $X + Y / Z$          | $(X + Y) / Z$    |
| $(X^2)^Y$            | $(X^2) ^ Y$      |
| $X^{YZ}$             | $X ^ (Y ^ Z)$    |
| $X(-Y)$              | $X * (-Y)$       |

Two consecutive operators **must** be separated by parentheses.

#### 6.4.1.1 Integer Division and Modulus Arithmetic

Two additional arithmetic operators are available: integer division and modulus arithmetic.

Integer division is denoted by the backslash (`\`). The operands are rounded to integers (**must** be within the range of -32768 to 32767) before the division is performed, and the quotient is truncated to an integer.

The following are examples of integer division:

$10 \backslash 4 = 2$   
 $25.68 \backslash 6.99 = 3$

In the order of occurrence within GW-BASIC, the integer division will be performed just after floating-point division.

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

The following are examples of modulus arithmetic:

$10.4 \text{ MOD } 4 = 2$   
 (10/4=2 with a remainder 2)  
 $25.68 \text{ MOD } 6.99 = 5$   
 (26/7=3 with a remainder 5)

In the order of occurrence within GW-BASIC, modulus arithmetic follows integer division. The `INT` and `FIX` functions, described in the GW-BASIC User's Reference, are also useful in modulus arithmetic.

### 6.4.1.2 Overflow and Division by Zero

If, during the evaluation of an expression, a division by zero is encountered, the "Division by zero" error message appears, machine infinity with the sign of the numerator is supplied 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 appears, positive machine infinity is supplied as the result of the exponentiation, and execution continues.

If overflow occurs, the "Overflow" error message appears, machine infinity with the algebraically correct sign is supplied as the result, and execution continues. The errors that occur in overflow and division by zero will not be trapped by the error trapping function.

### 6.4.2 Relational Operators

Relational operators let you compare two values. The result of the comparison is either true (-1) or false (0). This result can then be used to make a decision regarding program flow.

Table 6-1 displays the relational operators.

| Table 6.1: Relational Operators |                          |                   |
|---------------------------------|--------------------------|-------------------|
| 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              |

The equal sign is also used to assign a value to a variable. See the LET statement in the GW-BASIC User's Reference.

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

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

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

### 6.4.3 Logical Operators

Logical operators perform tests on multiple relations, bit manipulation, or boolean operations. The logical operator returns a bit-wise result which is either true (not zero) or false (zero). In an expression, logical operations are performed after arithmetic and relational operations. The outcome of a logical operation is determined as shown in the following table. The operators

are listed in order of precedence.

Table 6.2: Results Returned by Logical Operations

| Operation | Value | Value | Result  |
|-----------|-------|-------|---------|
| NOT       | X     |       | NOT X   |
|           | T     |       | F       |
|           | F     |       | T       |
| AND       | X     | Y     | X AND Y |
|           | T     | T     | T       |
|           | F     | F     | F       |
|           | F     | T     | F       |
|           | F     | F     | F       |
| OR        | X     | Y     | X OR Y  |
|           | T     | T     | T       |
|           | T     | F     | T       |
|           | F     | T     | T       |
|           | F     | F     | F       |
| XOR       | X     | Y     | X XOR Y |
|           | T     | T     | F       |
|           | T     | F     | T       |
|           | F     | T     | T       |
|           | F     | F     | F       |
| EQV       | X     | Y     | X EQV Y |
|           | T     | T     | T       |
|           | T     | F     | F       |
|           | F     | T     | F       |
|           | F     | F     | T       |
| IMP       | X     | Y     | X IMP Y |
|           | T     | T     | T       |
|           | T     | F     | F       |
|           | F     | T     | T       |
|           | F     | F     | T       |

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. For example:

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

Logical operators convert their operands to 16-bit, signed, two's complement integers within the range of -32768 to +32767 (if the operands are not within 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 bits; that is, each bit of the result is determined by the corresponding bits in the two operands.

Thus, it is possible to use logical operators to test bytes for a particular bit pattern. For instance, the AND operator may be 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 demonstrate how the logical operators work:

| Example        | Explanation  |
|----------------|--|
| 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 (10)   |
| -1 OR -2 = -1  | -1 = binary 1111111111111111 and -2 = binary 111111111111110, so -1 OR -2 = -1. The bit complement of 16 zeros is 16 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.  |

## 6.4.4 Functional Operators

A function is used in an expression to call a predetermined operation that is to be performed on an operand. GW-BASIC has intrinsic functions that reside in the system, such as SQR (square root) or SIN (sine).

GW-BASIC also allows user-defined functions written by the programmer. See the DEF FN statement in the GW-BASIC User's Reference.

## 6.4.5 String Operators

To compare strings, use the same relational operators used with numbers:

| Operator | Meaning                  |
|----------|--------------------------|
| =        | Equal to                 |
| <>       | Unequal                  |
| <        | Less than                |
| >        | Greater than             |
| <=       | Less than or equal to    |
| >=       | Greater than or equal to |

The GW-BASIC Interpreter compares strings by taking one character at a time from each string and comparing their ASCII codes. If the ASCII codes in each string are the same, the strings are equal. If the ASCII codes differ, the lower code number will precede the higher code. If the interpreter reaches the end of one string during string comparison, the shorter string is said to be smaller, providing that both strings are the same up to that point. Leading and trailing blanks are significant.

For example:

```
"AA" < "AB"  
"FILENAME" = "FILENAME"  
"X&" > "X#"  
"CL " > "CL"  
"kg" > "KG"  
"SMYTH" < "SMYTHE"  
BS < "9/12/78" where BS = "8/12/78"
```

String comparisons can also be used to test string values or to alphabetize strings. All string constants used in comparison expressions must be enclosed in quotation marks.

Strings can be concatenated by using the plus (+) sign. For example:

```
10 AS="FILE": BS="NAME"  
20 PRINT AS+BS  
30 PRINT "NEW " + AS+BS  
RUN  
FILENAME  
NEW FILENAME
```

# 7 Appendix A - Error Codes and Messages

Code: Message:

## 1 NEXT without FOR

NEXT statement does not have a corresponding FOR statement. Check variable at FOR statement for a match with the NEXT statement variable.

## 2 Syntax error

A line is encountered that contains an incorrect sequence of characters (such as unmatched parentheses, a misspelled command or statement, incorrect punctuation). This error causes GW-BASIC to display the incorrect line in edit mode.

## 3 RETURN without GOSUB

A RETURN statement is encountered for which there is no previous GOSUB statement.

## 4 Out of DATA

A READ statement is executed when there are no DATA statements with unread data remaining in the program.

## 5 Illegal function call

An out-of-range parameter is passed to a math or string function. An illegal function call error may also occur as the result of

- o a negative or unreasonably large subscript
- o a negative or zero argument with LOG
- o a negative argument to SQR
- o a negative mantissa with a noninteger power
- o a call to a USR function for which the starting address has not yet been given
- o an improper argument to MID\$, LEFT\$, RIGHT\$, INP, OUT, WAIT, PEEK, POKE, TAB, SPC, STRING\$, SPACES\$, INSTR, or ON...GOTO

## 6 Overflow

The result of a calculation is too large to be represented in GW-BASIC's number format. If underflow occurs, the result is zero, and execution continues without an error.

## 7 Out of memory

A program is too large, has too many FOR loops, GOSUBs, variables, or expressions that are too complicated. Use the CLEAR statement to set aside more stack space or memory area.

## 8 Undefined line number

A line reference in a GOTO, GOSUB, IF-THEN...ELSE, or DELETE is a nonexistent line.

## 9 Subscript out of range

An array element is referenced either with a subscript that is outside the dimensions of the array, or with the wrong number of subscripts.

## 10 Duplicate Definition

Two DIM statements are given for the same array, or a DIM statement is given for an array after the default dimension of 10 has been established for that array.

## 11 Division by zero

A division by zero is encountered in an expression, or the operation of involution 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 is entered as a direct mode command.

## 13 Type mismatch

A string variable name is assigned a numeric value or vice versa; a function that expects a numeric argument is given a string argument or vice versa.

## 14 Out of string space

String variables have caused GW-BASIC to exceed the amount of free memory remaining. GW-BASIC allocates string space dynamically until it runs out of memory.

## 15 String too long

An attempt is made to create a string more than 255 characters long.

16 String formula too complex

A string expression is too long or too complex. Break the expression into smaller expressions.

17 Can't continue

An attempt is made to continue a program that

- o has halted because of an error
- o has been modified during a break in execution
- o does not exist

18 Undefined user function

A **USR** function is called before the function definition (**DEF statement**) is given.

19 No **RESUME**

An error-trapping routine is entered but contains no **RESUME statement**.

20 **RESUME** without error

A **RESUME statement** is encountered before an error-trapping routine is entered.

21 Unprintable error

No error message is available for the existing error condition. This is usually caused by an error with an undefined error code.

22 Missing operand

An expression contains an operator with no operand following it.

23 Line buffer overflow

An attempt is made to input a line that has too many characters.

24 Device Timeout

**GW-BASIC** did not receive information from an I/O device within a predetermined amount of time.

25 Device Fault

Indicates a hardware error in the printer or interface card.

26 **FOR** Without **NEXT**

A **FOR** was encountered without a matching **NEXT**.

27 Out of Paper

The printer is out of paper; or, a printer fault.

28 Unprintable error

No error message is available for the existing error condition. This is usually caused by an error with an undefined error code.

29 WHILE without WEND

A WHILE statement does not have a matching WEND.

30 WEND without WHILE

A WEND was encountered without a matching WHILE.

31-49 Unprintable error

No error message is available for the existing error condition. This is usually caused by an error with an undefined error code.

50 FIELD overflow

A FIELD statement is attempting to allocate more bytes than were specified for the record length of a random file.

51 Internal error

An internal malfunction has occurred in GW-BASIC. Report to your dealer the conditions under which the message appeared.

52 Bad file number

A statement or command references a file with a file number that is not open or is out of range of file numbers specified at initialization.

53 File not found

A LOAD, KILL, NAME, FILES, or OPEN statement references a file that does not exist on the current diskette.

54 Bad file mode

An attempt is made to use PUT, GET, or LOF with a sequential file, to LOAD a random file, or to execute an OPEN with a file mode other than I, O, A, or R.

55 File already open

A sequential output mode OPEN is issued for a file that is already open, or a KILL is given for a file that is open.

## 56 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.

## 57 Device I/O Error

Usually a disk I/O error, but generalized to include all I/O devices. It is a fatal error; that is, the operating system cannot recover from the error.

## 58 File already exists

The filename specified in a NAME statement is identical to a filename already in use on the diskette.

## 59-60 Unprintable error

No error message is available for the existing error condition. This is usually caused by an error with an undefined error code.

## 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 (16,777,215) or equal to zero.

## 64 Bad filename

An illegal form is used for the filename with LOAD, SAVE, KILL, or OPEN; for example, a filename with too many characters.

## 65 Unprintable error

No error message is available for the existing error condition. This is usually caused by an error with an undefined error code.

## 66 Direct statement in file

A direct statement is encountered while loading a ASCII-format file. The LOAD is terminated.

## 67 Too many files

An attempt is made to create a new file (using SAVE or OPEN)

when all directory entries are full or the file specifications are invalid.

#### 68 Device Unavailable

An attempt is made to open a file to a nonexistent device. It may be that hardware does not exist to support the device, such as lpt2: or lpt3:, or is disabled by the user. This occurs if an OPEN "COM1: statement is executed but the user disables RS-232 support with the /c: switch directive on the command line.

#### 69 Communication buffer overflow

Occurs when a communications input statement is executed, but the input queue is already full. Use an ON ERROR GOTO statement to retry the input when this condition occurs. Subsequent inputs attempt to clear this fault unless characters continue to be received faster than the program can process them. In this case several options are available:

- o Increase the size of the COM receive buffer with the /c: switch.
- o Implement a hand-shaking protocol with the host/satellite (such as: XON/XOFF, as demonstrated in the TTY programming example) to turn transmit off long enough to catch up.
- o Use a lower baud rate for transmit and receive.

#### 70 Permission Denied

This is one of three hard disk errors returned from the diskette controller.

- o An attempt has been made to write onto a diskette that is write protected.
- o Another process has attempted to access a file already in use.
- o The UNLOCK range specified does not match the preceding LOCK statement.

#### 71 Disk not Ready

Occurs when the diskette drive door is open or a diskette is not in the drive. Use an ON ERROR GOTO statement to recover.

#### 72 Disk media error

Occurs when the diskette controller detects a hardware or media fault. This usually indicates damaged media. Copy any existing files to a new diskette, and reformat the damaged diskette. FORMAT maps the bad tracks in the file allocation table. The remainder of the diskette is now usable.



## 73 Advanced Feature

An attempt was made to use a reserved word that is not available in this version of GW-BASIC.

## 74 Rename across disks

Occurs when an attempt is made to rename a file to a new name declared to be on a disk other than the disk specified for the old name. The naming operation is not performed.

## 75 Path/File Access Error

During an OPEN, MKDIR, CHDIR, or RMDIR operation, MS-DOS is unable to make a correct path-to-filename connection. The operation is not completed.

## 76 Path not found

During an OPEN, MKDIR, CHDIR, or RMDIR operation, MS-DOS is unable to find the path specified. The operation is not completed.

# 8 Appendix B - Mathematical Functions

Mathematical functions not intrinsic to GW-BASIC can be calculated as follows:

| Function          | GW-BASIC Equivalent  |
|-------------------|--|
| Secant            | $\text{SEC}(X) = 1/\text{COS}(X)$  |
| Cosecant          | $\text{CSC}(X) = 1/\text{SIN}(X)$  |
| Cotangent         | $\text{COT}(X) = 1/\text{TAN}(X)$  |
| Inverse Sine      | $\text{ARCSIN}(X) = \text{ATN}(X/\text{SQR}(-X*X+1))$  |
| Inverse Cosine    | $\text{ARCCOS}(X) = \text{ATN}(X/\text{SQR}(-X*X+1)) + \text{pi}/2$                              |
| Inverse Secant    | $\text{ARCSEC}(X) = \text{ATN}(X/\text{SQR}(X*X-1)) + \text{SGN}(\text{SGN}(X)-1) * \text{pi}/2$ |
| Inverse Cosecant  | $\text{ARCCSC}(X) = \text{ATN}(X/\text{SQR}(X*X-1)) + \text{SGN}(X)-1 * \text{pi}/2$             |
| Inverse Cotangent | $\text{ARCCOT}(X) = \text{ATN}(X) + \text{pi}/2$   |
| Hyperbolic Sine   | $\text{SINH}(X) = (\text{EXP}(X) - \text{EXP}(-X))/2$  |

|                              |  |
|------------------------------|--|
| Function                     | GW-BASIC Equivalent  |
| Hyperbolic Cosine            | $\text{COSH}(X) = (\text{EXP}(X) + \text{EXP}(-X)) / 2$                                |
| Hyperbolic Tangent           | $\text{TANH}(X) = (\text{EXP}(X) - \text{EXP}(-X)) / (\text{EXP}(X) + \text{EXP}(-X))$ |
| Hyperbolic Secant            | $\text{SECH}(X) = 2 / (\text{EXP}(X) + \text{EXP}(-X))$                                |
| Hyperbolic Cosecant          | $\text{CSCH}(X) = 2 / (\text{EXP}(X) - \text{EXP}(-X))$                                |
| Hyperbolic Cotangent         | $\text{COTH}(X) = (\text{EXP}(X) + \text{EXP}(-X)) / (\text{EXP}(X) - \text{EXP}(-X))$ |
| Inverse Hyperbolic Sine      | $\text{ARCSINH}(X) = \text{LOG}(X + \text{SQR}(X^2 + 1))$                              |
| Inverse Hyperbolic Cosine    | $\text{ARCCOSH}(X) = \text{LOG}(X + \text{SQR}(X^2 - 1))$                              |
| Inverse Hyperbolic Tangent   | $\text{ARCTANH}(X) = \text{LOG}((1 + X) / (1 - X)) / 2$                                |
| Inverse Hyperbolic Cosecant  | $\text{ARCCSCH}(X) = \text{LOG}(\text{SGN}(X) * \text{SQR}(X^2 + 1) + 1) / X$          |
| Inverse Hyperbolic Secant    | $\text{ARCSECH}(X) = \text{LOG}(\text{SQR}(X^2 + 1) + 1) / X$                          |
| Inverse Hyperbolic Cotangent | $\text{ARCCOTH}(X) = \text{LOG}((X + 1) / (X - 1)) / 2$                                |

## 9 Appendix C - ASCII Character Codes

| Dec | Oct | Hex | Chr | Dec | Oct | Hex | Chr |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 000 | 000 | 00H | NUL | 032 | 040 | 20H | SP  |
| 001 | 001 | 01H | SOH | 033 | 041 | 21H | !   |
| 002 | 002 | 02H | STX | 034 | 042 | 22H | "   |
| 003 | 003 | 03H | ETX | 035 | 043 | 23H | #   |
| 004 | 004 | 04H | EOT | 036 | 044 | 24H | \$  |
| 005 | 005 | 05H | ENQ | 037 | 045 | 25H | %   |
| 006 | 006 | 06H | ACK | 038 | 046 | 26H | &   |
| 007 | 007 | 07H | BEL | 039 | 047 | 27H | '   |
| 008 | 010 | 08H | BS  | 040 | 050 | 28H | (   |
| 009 | 011 | 09H | HT  | 041 | 051 | 29H | )   |
| 010 | 012 | 0AH | LF  | 042 | 052 | 2AH | *   |
| 011 | 013 | 0BH | VT  | 043 | 053 | 2BH | +   |
| 012 | 014 | 0CH | FF  | 044 | 054 | 2CH | ,   |
| 013 | 015 | 0DH | CR  | 045 | 055 | 2DH | -   |
| 014 | 016 | 0EH | SO  | 046 | 056 | 2EH | .   |
| 015 | 017 | 0FH | SI  | 047 | 057 | 2FH | /   |
| 016 | 020 | 10H | DLE | 048 | 060 | 30H | 0   |
| 017 | 021 | 11H | DC1 | 049 | 061 | 31H | 1   |
| 018 | 022 | 12H | DC2 | 050 | 062 | 32H | 2   |
| 019 | 023 | 13H | DC3 | 051 | 063 | 33H | 3   |
| 020 | 024 | 14H | DC4 | 052 | 064 | 34H | 4   |
| 021 | 025 | 15H | NAK | 053 | 065 | 35H | 5   |
| 022 | 026 | 16H | SYN | 054 | 066 | 36H | 6   |
| 023 | 027 | 17H | ETB | 055 | 067 | 37H | 7   |
| 024 | 030 | 18H | CAN | 056 | 070 | 38H | 8   |
| 025 | 031 | 19H | EM  | 057 | 071 | 39H | 9   |
| 026 | 032 | 1AH | SUB | 058 | 072 | 3AH | :   |
| 027 | 033 | 1BH | ESC | 059 | 073 | 3BH | ;   |
| 028 | 034 | 1CH | FS  | 060 | 074 | 3CH | <   |
| 029 | 035 | 1DH | GS  | 061 | 075 | 3DH | =   |
| 030 | 036 | 1EH | RS  | 062 | 076 | 3EH | >   |
| 031 | 037 | 1FH | US  | 063 | 077 | 3FH | ?   |

| Dec | Oct | Hex | Chr | Dec | Oct | Hex | Chr |
|-----|-----|-----|-----|-----|-----|-----|-----|
| 064 | 100 | 40H | @   | 096 | 140 | 60H | `   |
| 065 | 101 | 41H | A   | 097 | 141 | 61H | a   |
| 066 | 102 | 42H | B   | 098 | 142 | 62H | b   |
| 067 | 103 | 43H | C   | 099 | 143 | 63H | c   |
| 068 | 104 | 44H | D   | 100 | 144 | 64H | d   |
| 069 | 105 | 45H | E   | 101 | 145 | 65H | e   |
| 070 | 106 | 46H | F   | 102 | 146 | 66H | f   |
| 071 | 107 | 47H | G   | 103 | 147 | 67H | g   |
| 072 | 110 | 48H | H   | 104 | 150 | 68H | h   |
| 073 | 111 | 49H | I   | 105 | 151 | 69H | i   |
| 074 | 112 | 4AH | J   | 106 | 152 | 6AH | j   |
| 075 | 113 | 4BH | K   | 107 | 153 | 6BH | k   |
| 076 | 114 | 4CH | L   | 108 | 154 | 6CH | l   |
| 077 | 115 | 4DH | M   | 109 | 155 | 6DH | m   |
| 078 | 116 | 4EH | N   | 110 | 156 | 6EH | n   |
| 079 | 117 | 4FH | O   | 111 | 157 | 6FH | o   |
| 080 | 120 | 50H | P   | 112 | 160 | 70H | p   |
| 081 | 121 | 51H | Q   | 113 | 161 | 71H | q   |
| 082 | 122 | 52H | R   | 114 | 162 | 72H | r   |
| 083 | 123 | 53H | S   | 115 | 163 | 73H | s   |
| 084 | 124 | 54H | T   | 116 | 164 | 74H | t   |
| 085 | 125 | 55H | U   | 117 | 165 | 75H | u   |
| 086 | 126 | 56H | V   | 118 | 166 | 76H | v   |
| 087 | 127 | 57H | W   | 119 | 167 | 77H | w   |
| 088 | 130 | 58H | X   | 120 | 170 | 78H | x   |
| 089 | 131 | 59H | Y   | 121 | 171 | 79H | y   |
| 090 | 132 | 5AH | Z   | 122 | 172 | 7AH | z   |
| 091 | 133 | 5BH | [   | 123 | 173 | 7BH | {   |
| 092 | 134 | 5CH | \   | 124 | 174 | 7CH |     |
| 093 | 135 | 5DH | ]   | 125 | 175 | 7DH | }   |
| 094 | 136 | 5EH | ^   | 126 | 176 | 7EH | ~   |
| 095 | 137 | 5FH | -   | 127 | 177 | 7FH | DEL |

Dec=Decimal, Oct=Octal, Hex=Hexadecimal (H), Chr=Character, LF=Line feed  
FF=Form feed, CR=Carriage return, DEL=Rubout, SP=Space (Blank)

## 10 Appendix D - Assembly Language (Machine Code) Subroutines

This appendix is written primarily for users experienced in assembly language programming.

GW-BASIC lets you interface with assembly language subroutines by using the USR function and the CALL statement.

The USR function allows assembly language subroutines to be called in the same way GW-BASIC intrinsic functions are called. However, the CALL statement is recommended for interfacing machine language programs with GW-BASIC. The CALL statement is compatible with more languages than the USR function call, produces more readable source code, and can pass multiple arguments.

## 10.1 Memory Allocation

Memory space must be set aside for an assembly language (or machine code) subroutine before it can be loaded. There are three recommended ways to set aside space for assembly language routines:

- o Specify an array and use VARPTR to locate the start of the array before every access.
- o Use the /m switch in the command line. Get GW-BASIC's Data segment (DS), and add the size of DS to reference the reserved space above the data segment.
- o Execute a .COM file that stays resident, and store a pointer to it in an unused interrupt vector location.

There are three recommended ways to load assembly language routines:

- o BLOAD the file. Use DEBUG to load in an .EXE file that is in high memory, run GW-BASIC, and BSAVE the .EXE file.
- o Execute a .COM file that contains the routines. Save the pointer to these routines in unused interrupt-vector locations, so that your application in GW-BASIC can get the pointer and use the routine(s).
- o Place the routine into the specified area.

If, when an assembly language subroutine is called, more stack space is needed, GW-BASIC stack space can be saved, and a new stack set up for use by the assembly language subroutine. The GW-BASIC stack space must be restored, however, before returning from the subroutine.

## 10.2 CALL Statement

`CALL variablename[(arguments)]`

`variablename` contains the offset in the current segment of the subroutine being called.

`arguments` are the variables or constants, separated by commas, that are to be passed to the routine.

For each parameter in `arguments`, the 2-byte offset of the parameter's location within the data segment (DS) is pushed onto the stack.

The GW-BASIC return address code segment (CS), and offset (IP) are pushed onto the stack.

A long call to the segment address given in the last DEF SEG statement and the offset given in `variablename` transfers control to the user's routine.

The stack segment (SS), data segment (DS), extra segment (ES), and the stack pointer (SP) must be preserved.

The user's routine now has control. Parameters may be referenced by moving the stack pointer (SP) to the base pointer (BP) and adding a positive offset to BP.

Upon entry, the segment registers DS, ES, and SS all point to the address of the segment that contains the GW-BASIC interpreter code. The code segment register CS contains the latest value supplied by DEF SEG. If no DEF SEG has been specified, it then points to the same address as DS, ES, and SS (the default DEF SEG).

The following seven rules must be observed when coding a subroutine:

1. The called routine may destroy the contents of the AX, BX, CX, DX, SI, DI, and BP registers. They do not require restoration upon return to GW-BASIC. However, all segment registers and the stack pointer must be restored. Good programming practice dictates that interrupts enabled or disabled be restored to the state observed upon entry.
2. The called program must know the number and length of the parameters passed. References to parameters are positive offsets added to BP, assuming the called routine moved the current stack pointer into BP; that is, MOV BP, SP. When 3 parameters are passed, the location of P0 is at BP+10, P1 is at BP+8, and P2 is at BP+6.
3. The called routine must do a RETURN n (n is two times the number of parameters in the argument list) to adjust the stack to the start of the calling sequence. Also, programs must be defined by a PROC FAR statement.
4. Values are returned to GW-BASIC by including in the argument list the variable name that receives the result.
5. If the argument is a string, the parameter offset points to three bytes called the string descriptor. Byte 0 of the string descriptor contains the length of the string (0 to 255). Bytes 1 and 2, respectively, are the lower and upper eight bits of the string starting address in string space.

#### Note

The called routine must not change the contents of any of the three bytes of the string descriptor.

6. Strings may be altered by user routines, but their length must not be changed. GW-BASIC cannot correctly manipulate strings if their lengths are modified by external routines.
7. If the argument is a string literal in the program, the string descriptor points to program text. Be careful not to alter or destroy your program this way. To avoid unpredictable results, add "+" to the string literal in the program. For example, the following line forces the string literal to be copied into string space allocated outside of program memory space:

```
20 A$="BASIC"+""
```

The string can then be modified without affecting the program.

### Examples:

```
100 DEF SEG=&H2000
110 ACC=&H7FA
120 CALL ACC(A, B$, C)
```

```
.
.
.
```

Line 100 sets the segment to 2000 hex. The value of variable ACC is added into the address as the low word after the DEF SEG value is left-shifted four bits (this is a function of the microprocessor, not of GW-BASIC). Here, ACC is set to &H7FA, so that the call to ACC executes the subroutine at location 2000:7FA hex.

Upon entry, only 16 bytes (eight words) remain available within the allocated stack space. If the called program requires additional stack space, then the user program must reset the stack pointer to a new allocated space. Be sure to restore the stack pointer adjusted to the start of the calling sequence on return to GW-BASIC.

The following assembly language sequence demonstrates access of the parameters passed and storage of a return result in the variable C.

### Note

The called program must know the variable type for numeric parameters passed. In these examples, the following instruction copies only two bytes:

### MOVSW

This is adequate if variables A and C are integer. It would be necessary to copy four bytes if they were single precision, or copy eight bytes if they were double precision.

```
MOV BP, SP Gets the current stack position in BP
MOV BX, 8[BP] Gets the address of B$ description
MOV CL, [BX] Gets the length of B$ in CL
MOV DX, 1[BX] Gets the address of B$ string descriptor in DX
MOV SI, 10[BP] Gets the address of A in SI
MOV DI, 6[BP] Gets the pointer to C in DI
MOVSW Stores variable A in 'C'
RET 6 Restores stack; returns
```

## 10.3 USR Function Calls

Although the CALL statement is the recommended way of calling assembly language subroutines, the USR function call is still available for compatibility with previously-written programs.

Syntax:

USR[n](argument)

n is a number from 0 to 9 which specifies the USR routine being called (see DEF USR statement). If n is omitted, USR0 is assumed.

argument is any numeric or string expression.

In GW-BASIC a DEF SEG statement should be executed prior to a USR function call to ensure that the code segment points to the subroutine being called. The segment address given in the DEF SEG statement determines the starting segment of the subroutine.

For each USR function call, a corresponding DEF USR statement must have been executed to define the USR function call offset. This offset and the currently active DEF SEG address determine the starting address of the subroutine.

When the USR function call is made, register AL contains the number type flag (NTF), which specifies the type of argument given. The NTF value may be one of the following:

| NTF Value | Specifies                                    |
|-----------|--|
| 2         | a two-byte integer (two's complement format) |
| 3         | a string                                     |
| 4         | a single-precision floating point number     |
| 8         | a double-precision floating point number     |

If the argument of a USR function call is a number ( $AL \neq 73$ ), the value of the argument is placed in the floating-point accumulator (FAC). The FAC is 8 bytes long and is in the GW-BASIC data segment. Register BX will point at the fifth byte of the FAC. Figure D.3 shows the representation of all the GW-BASIC number types in the FAC:

If the argument is a single-precision floating-point number:

- o BX+3 is the exponent, minus 128. The binary point is to the left of the most significant bit of the mantissa.
- o BX+2 contains the highest seven bits of mantissa with leading 1 suppressed (implied). Bit 7 is the sign of the number (0=positive, 1=negative).
- o BX+1 contains the middle 8 bits of the mantissa.



- o BX+0 contains the lowest 8 bits of the mantissa.

If the argument is an integer:

- o BX+1 contains the upper eight bits of the argument.

- o BX+0 contains the lower eight bits of the argument.

If the argument is a double-precision floating-point number:

- o BX+0 through BX+3 are the same as for single precision floating point.

- o BX-1 to BX-4 contain four more bytes of mantissa. BX-4 contains the lowest eight bits of the mantissa.

If the argument is a string (indicated by the value 3 stored in the AL register) the (DX) 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 1 and 2, respectively, are the lower- and upper-eight bits of the string starting address in the GW-BASIC data segment.

If the argument is a string literal in the program, the string descriptor points to program text. Be careful not to alter or destroy programs this way (see the preceding CALL statement).

Usually, the value returned by a USR function call is the same type (integer, string, single precision, or double precision) as the argument that was passed to it. The registers that must be preserved are the same as in the CALL statement.

A far return is required to exit the USR subroutine. The returned value must be stored in the FAC.

## 10.4 Programs That Call Assembly Language Programs

This section contains two sample GW-BASIC programs that

- o load an assembly language routine to add two numbers together

- o return the sum into memory

- o remain resident in memory

The code segment and offset to the first routine is stored in interrupt vector at 0:100H.

Example 1 calls an assembly language subroutine:

## Example 1

```
10 DEF SEG=0
100 CS=PEEK(&H102)+PEEK(&H103)*256
200 OFFSET=PEEK(&H100)+PEEK(&H101)*256
250 DEF SEG
300 C1%=2: C2%=3: C3%=0
400 TWOSUM=OFFSET
500 DEF SEG=CS
600 CALL TWOSUM(C1%, C2%, C3%)
700 PRINT C3%
800 END
```

The assembly language subroutine called in the above program must be assembled, linked, and converted to a .COM file. The program, when executed prior to the running of the GW-BASIC program, will remain in memory until the system power is turned off, or the system is rebooted.

```
0100 org 100H
0100 double segment
      assume cs:double
0100 EB 17 90 start: jmp start1
0103 usrprg proc far
0103 55 push bp
0104 8B EC mov bp, sp
0106 8B 76 08 mov si, [bp]+8 ;get address of
                                ;parameter b
0109 8B 04 mov ax, [si] ;get value of b
010B 8B 76 0A mov si, [bp]+10 ;get address of
                                ;parameter a
010E 03 04 add ax, [si] ;add value of
                                ;a to value of
                                ;b
0110 8B 7E 06 mov di, [bp]+6 ;get address of
                                ;parameter c
0113 89 05 mov di, ax ;store sum in
                                ;parameter c

0115 5D pop bp
0116 CA 0006 ret 6
0119 usrprg endp

                                ;
                                ;Program to put procedure
                                ;in memory and remain
                                ;resident. The offset and
                                ;segment are stored in
                                ;location 100-103H.

0119 start1:
0119 B8 0000 mov ax, 0
011C 8E D8 mov ds, ax ;data segment to 0000H
011E BB 0100 mov bx, 0100H ;pointer to int vector 100H
0121 83 7F 02 0 cmp word ptr [bx], 0
0125 75 16 jne quit ;program
                                ;already run,
                                ;exit
0127 83 3F 00 cmp word ptr2 [bx], 0
```

```

012A 75 11 jne quit ; program
                                ; already run,
                                ; exit
012C B8 0103 R mov ax, offset usrprg
012F 89 07 mov [bx], ax ; program offset
0131 8C c8 mov ax, cs
0133 89 47 02 mov [bx+2], ax ; data segment
0136 0E push cs
0137 1F pop ds
0138 BA 0141 R mov dx, offset veryend
013B CD 27 int 27h
013D quit:
013D CD 20 int 20h
013F veryend:
013F double ends
      end start

```

Example 2 places the assembly language subroutine in the specified area:

#### Example 2

```

10 I=0: JC=0
100 DIM A%(23)
150 MEM%=VARPTR(A%(1))
200 FOR I=1 TO 23
300 READ JC
400 POKE MEM%, JC
450 MEM%=MEM%+1
500 NEXT
600 C1%=2: C2%=3: C3%=0
700 TWOSUM=VARPTR(A%(1))
800 CALL TWOSUM(C1%, C2%, C3%)
900 PRINT C3%
950 END
1000 DATA &H55, &H8b, &Hec &H8b, &H76, &H08, &H8b, &H04, &H8b, &H76
1100 DATA &H0a, &H03, &H04, &H8b, &H7e, &H06, &H89, &H05, &H5d
1200 DATA &Hca, &H06, &H00

```

## 11 Appendix E - Converting BASIC Programs to GW-BASIC

Programs written in a BASIC language other than GW-BASIC may require some minor adjustments before they can be run. The following sections describe these adjustments.

### 11.1 String Dimensions

Delete all statements used to declare the length of strings. A statement such as the following:

```
DIM A$(I, J)
```

which dimensions a string array for J elements of length I, should be converted to the following statement:

```
DIM A$(J)
```

Some GW-BASIC languages use a comma or ampersand (&) for string concatenation. Each of these must be changed to a plus sign (+), which is the operator for GW-BASIC string concatenation.

In GW-BASIC, the MID\$, RIGHT\$, and LEFT\$ functions are used to take substrings of strings. Forms such as A\$(I) to access the Ith character in A\$, or A\$(I, J) to take a substring of A\$ from position I to position J, must be changed as follows:

|               |                          |
|---------------|--------------------------|
| Other BASIC:  | GW-BASIC:                |
| X\$=A\$(I)    | X\$=MID\$(A\$, I, 1)     |
| X\$=A\$(I, J) | X\$=MID\$(A\$, I, J-I+1) |

If the substring reference is on the left side of an assignment, and X\$ is used to replace characters in A\$, convert as follows:

|               |                          |
|---------------|--------------------------|
| Other BASIC:  | GW-BASIC:                |
| A\$(I)=X\$    | MID\$(A\$, I, 1)=X\$     |
| A\$(I, J)=X\$ | MID\$(A\$, I, J-I+1)=X\$ |

## 11.2 Multiple Assignments

Some BASIC languages allow statements of the following form to set B and C equal to zero:

```
10 LET B=C=0
```

GW-BASIC would interpret the second equal sign as a logical operator and set B equal to -1 if C equaled 0. Convert this statement to two assignment statements:

```
10 C=0: B=0
```

## 11.3 Multiple Statements

Some GW-BASIC languages use a backslash (\) to separate multiple statements on a line. With GW-BASIC, be sure all elements on a line are separated by a colon (:).

## 11.4 MAT Functions

Programs using the MAT functions available in some BASIC languages must be rewritten using FOR-NEXT loops to execute properly.

## 11.5 FOR-NEXT Loops

Some BASIC languages will always execute a FOR-NEXT loop once, regardless of the limits. GW-BASIC checks the limits first and does not execute the loop if past limits.

## 12 Appendix F - Communications

This appendix describes the GW-BASIC statements necessary to support RS-232 asynchronous communications with other computers and peripheral devices.

### 12.1 Opening Communications Files

The OPEN COM statement allocates a buffer for input and output in the same manner as the OPEN statement opens disk files.

### 12.2 Communications I/O

Since the communications port is opened as a file, all I/O statements valid for disk files are valid for COM.

COM sequential input statements are the same as those for disk files:

```
INPUT#  
LINE INPUT#  
INPUT$
```

COM sequential output statements are the same as those for diskette:

```
PRINT#  
PRINT# USING
```

See the GW-BASIC User's Reference for more information on these statements.

### 12.3 The COM I/O Functions

The most difficult aspect of asynchronous communications is processing characters as quickly as they are received. At rates above 2400 baud (bps), it is necessary to suspend character transmission from the host long enough for the receiver to catch up. This can be done by sending XOFF (CTRL-S) to the host to temporarily suspend transmission, and XON (CTRL-Q) to resume, if the application supports it.

GW-BASIC provides three functions which help to determine when an overrun condition is imminent:

**LOC(x)** Returns the number of characters in the input queue waiting to be read. The input queue can hold more than 255 characters (determined by the /c: switch). If there are more than 255 characters in the queue, LOC(x) returns 255. Since a string is limited to 255 characters, this practical limit alleviates the need for the programmer to test for string size before reading data into it.

**LOF(x)** Returns the amount of free space in the input queue; that is /c:(size)-number of characters in the input queue. LOF may be used to detect when the input queue is reaching storage capacity.

**EOF(x)** True (-1), indicates that the input queue is empty. False (0) is returned if any characters are waiting to be read.

## 12.4 Possible Errors:

A "Communications buffer overflow" error occurs if a read is attempted after the input queue is full (that is, LOC(x) returns 0).

A "Device I/O" error occurs if any of the following line conditions are Detected on receive: overrun error (OE), framing error (FE), or break interrupt (BI). The error is reset by subsequent inputs, but the character causing the error is lost.

A "Device fault" error occurs if data set ready (DSR) is lost during I/O.

A "Parity error" occurs if the PE (parity enable) option was used in the OPEN COM statement and incorrect parity was received.

## 12.5 The INPUT\$ Function

The INPUT\$ function is preferred over the INPUT and LINE INPUT statements for reading COM files, because all ASCII characters may be significant in communications. INPUT is least desirable because input stops when a comma or an enter is seen. LINE INPUT terminates when an enter is seen.

INPUT\$ allows all characters read to be assigned to a string.

INPUT\$ returns x characters from the y file. The following statements then are most efficient for reading a COM file:

```
10 WHILE NOT EOF(1)
20 AS=INPUT$(LOC(1), #1)
30 ...
40 ... Process data returned in AS ...
50 ...
60 WEND
```

This sequence of statements translates: As long as something is in the input queue, return the number of characters in the queue and store them in AS. If there are more than 255 characters, only 255 are returned at a time to prevent string overflow. If this is the case, EOF(1) is false, and input continues until the input queue is empty.

## GET and PUT Statements for COM Files

### Purpose:

To allow fixed-length I/O for COM

### Syntax:

GET filename, nbytes PUT filename, nbytes

### Comments:

filename is an integer expression returning a valid file number.

nbytes is an integer expression returning the number of bytes to be transferred into or out of the file buffer. nbytes cannot exceed the value set by the /s: switch when GW-BASIC was invoked.

Because of the low performance associated with telephone line communications, it is recommended that GET and PUT not be used in such applications.

### Example:

The following TTY sample program is an exercise in communications I/O. It is designed to enable your computer to be used as a conventional terminal. Besides full-duplex communications with a host, the TTY program allows data to be downloaded to a file. Conversely, a file may be uploaded (transmitted) to another machine.

In addition to demonstrating the elements of asynchronous communications, this program is useful for transferring GW-BASIC programs and data to and from a computer.

### Note

This program is set up to communicate with a DEC (R) SYSTEM-20 especially in the use of XON and XOFF. It may require modification to communicate with other types of hardware.

## 12.6 The TTY Sample Program

```
10 SCREEN 0,0:WIDTH 80
15 KEY OFF:CLS:CLOSE
20 DEFINT A-Z
25 LOCATE 25,1
30 PRINT STRING$(60," ")
40 FALSE=0:TRUE=NOT FALSE
50 MENU=5 'Value of MENU Key (^E)
60 XOFF$=CHR$(19):XON$=CHR$(17)
100 LOCATE 25,1:PRINT "Async TTY Program";
110 LOCATE 1,1:LINE INPUT "Speed?";"SPEED$
120 COMFIL$="COM1: , +SPEED$+",E,7"
130 OPEN COMFIL$ AS #1
140 OPEN "SCRN:"FOR OUTPUT AS #3
200 PAUSE=FALSE
210 A$=INKEY$:IF A$=""THEN 230
220 IF ASC(A$)=MENU THEN 300 ELSE PRINT #1,A$;
230 IF EOF(1) THEN 210
240 IF LOC(1)>128 THEN PAUSE=TRUE:PRINT #1,XOFF$;
250 A$=INPUT$(LOC(1),#1)
260 PRINT #3,A$;:IF LOC(1)>0 THEN 240
270 IF PAUSE THEN PAUSE=FALSE:PRINT #1,XON$;
280 GOTO 210
300 LOCATE 1,1:PRINT STRING$(30,32):LOCATE 1,1
310 LINE INPUT "FILE?";DSKFIL$
400 LOCATE 1,1:PRINT STRING$(30,32):LOCATE 1,1
410 LINE INPUT"(T)ransmit or (R)eceive?";TXRX$
420 IF TXRX$="T" THEN OPEN DSKFIL$ FOR INPUT AS #2:GOTO 1000
430 OPEN DSKFIL$ FOR OUTPUT AS #2
440 PRINT #1,CHR$(13);
500 IF EOF(1) THEN GOSUB 600
510 IF LOC(1)>128 THEN PAUSE=TRUE:PRINT #1,XOFF$;
520 A$=INPUT$(LOC(1),#1)
530 PRINT #2,A$;:IF LOC(1)>0 THEN 510
540 IF PAUSE THEN PAUSE=FALSE:PRINT #1,XON$;
550 GOTO 500
600 FOR I=1 TO 5000
610 IF NOT EOF(1) THEN I=9999
620 NEXT I
630 IF I>9999 THEN RETURN
640 CLOSE #2;CLS:LOCATE 25,10:PRINT "* Download complete *";
650 RETURN 200
1000 WHILE NOT EOF(2)
1010 A$=INPUT$(1,#2)
1020 PRINT #1,A$;
1030 WEND
1040 PRINT #1,CHR$(28);^Z to make close file.
1050 CLOSE #2:CLS:LOCATE 25,10:PRINT "*** Upload complete ***";
1060 GOTO 200
9999 CLOSE:KEY ON
```



## 12.7 Notes on the TTY Sample Program

### Note

Asynchronous implies character I/O as opposed to line or block I/O. Therefore, all prints (either to the COM file or screen) are terminated with a semicolon (;). This retards the return line feed normally issued at the end of the PRINT statement.

Line Number    Comments

10 Sets the SCREEN to black and white alpha mode and sets the width to 80.

15 Turns off the soft key display, clears the screen, and makes sure that all files are closed.

20 Defines all numeric variables as integer, primarily for the benefit of the subroutine at 600-620. Any program looking for speed optimization should use integer counters in loops where possible.

40 Defines boolean true and false.

50 Defines the ASCII (ASC) value of the MENU key.

60 Defines the ASCII XON and XOFF characters.

100-130 Prints program ID and asks for baud rate (speed). Opens communications to file number 1, even parity, 7 data bits.

200-280 This section performs full-duplex I/O between the video screen and the device connected to the RS-232 connector as follows:

1. Read a character from the keyboard into AS\$. INKEY\$ returns a null string if no character is waiting.

2. If a keyboard character is available, waiting, then:

If the character is the MENU key, the operator is ready to down-load a file. Get filename.

If the character (AS) is not the MENU key send it by writing to the communications file (PRINT #1...).

3. If no character is waiting, check to see if any characters are being received.

4. At 230, see if any characters are waiting in COM buffer. If not, go back and check the keyboard.

5. At 240, if more than 128 characters are waiting, set PAUSE flag to indicate that input is being suspended. Send XOFF to host, stopping further transmission.

6. At 250-260, read and display contents of COM buffer on screen until empty. Continue to monitor size of COM buffer (in 240). Suspend transmission if reception falls behind.

7. Resume host transmission by sending XON only if suspended by previous XOFF.

8. Repeat process until the MENU key is pressed.

300-320 Get disk filename to be down-loaded to. Open the file as number 2.

400-420 Asks if file named is to be transmitted (up-loaded) or received (down-loaded).

430 Receive routine. Sends a RETURN to the host to begin the down-load. This program assumes that the last command sent to the host was to begin such a transfer and was missing only the terminating return. If a DEC system is the host, such a command might be

COPY TTY: =MANUAL. MEM (MENU Key)

if the MENU key was struck instead of RETURN.

500 When no more characters are being received, (LOC(x) returns 0), then performs a timeout routine.

510 If more than 128 characters are waiting, signal a pause and send XOFF to the host.

520-530 Read all characters in COM queue (LOC(x)) and write them to diskette (PRINT #2...) until reception is caught up to transmission.

540-550 If a pause is issued, restart host by sending XON and clearing the pause flag. Continue the process until no characters are received for a predetermined time.

600-650 Time-out subroutine. The FOR loop count was determined by experimentation. If no character is received from the host for 17-20 seconds, transmission is assumed complete. If any character is received during this time (line 610), then set n well above the FOR loop range to exit loop and return to caller. If host transmission is com-

plete, close the disk file and resume regular activities.

1000-1060 Transmit routine. Until end of disk file, read one character into AS with INPUT\$ statement. Send character to COM device in 1020. Send a ^Z at end of file in 1040 in case receiving device needs one to close its file. Lines 1050 and 1060 close disk file, print completion message, and go back to conversation mode in line 200.

9999 Presently not executed. As an exercise, add some lines to the routine 400-420 to exit the program via line 9999. This line closes the COM file left open and restores the function key display.

## 13 Appendix G - Hexadecimal Equivalents

Table G.1 lists decimal and binary equivalents to hexadecimal values.

| Table G.1: Decimal and Binary Equivalents to Hexadecimal Values |                  |                |
|---|------------------|----------------|
| Hexadecimal Value   | Equals Decimal : | Equals Binary: |
| 0   | 0                | 0000           |
| 1   | 1                | 0001           |
| 2   | 2                | 0010           |
| 3   | 3                | 0011           |
| 4   | 4                | 0100           |
| 5   | 5                | 0101           |
| 6   | 6                | 0110           |
| 7   | 7                | 0111           |
| 8   | 8                | 1000           |
| 9   | 9                | 1001           |
| A   | 10               | 1010           |
| B   | 11               | 1011           |
| C   | 12               | 1100           |
| D   | 13               | 1101           |
| E   | 14               | 1110           |
| F   | 15               | 1111           |

Table G.2 lists decimal equivalents to hexadecimal values.

| <u>Table G.2: Decimal Equivalents to Hexadecimal Values</u> |                  |                    |                  |
|---|------------------|--------------------|------------------|
| Hexadecimal Value   | Equals Decimal : | Hexadecimal Value: | Equals Decimal : |
| 0   | 0                | 80                 | 128              |
| 1   | 1                | .                  |                  |
| 2   | 2                | .                  |                  |
| 3   | 3                | .                  |                  |
| 4   | 4                | 90                 | 144              |
| 5   | 5                | .                  |                  |
| 6   | 6                | .                  |                  |
| 7   | 7                | .                  |                  |
| 8   | 8                | A0                 | 160              |
| 9   | 9                | .                  |                  |
| A   | 10               | .                  |                  |
| B   | 11               | .                  |                  |
| C   | 12               | B0                 | 176              |
| D   | 13               | .                  |                  |
| E   | 14               | .                  |                  |
| F   | 15               | .                  |                  |
| 10  | 16               | C0                 | 192              |
| 11  | 17               | .                  |                  |
| 12  | 18               | .                  |                  |
| 13  | 19               | .                  |                  |
| 14  | 20               | D0                 | 208              |
| 15  | 21               | .                  |                  |
| 16  | 22               | .                  |                  |
| 17  | 23               | .                  |                  |
| 18  | 24               | E0                 | 224              |
| 19  | 25               | .                  |                  |
| 1A  | 26               | .                  |                  |
| 1B  | 27               | .                  |                  |
| 1C  | 28               | F0                 | 240              |
| 1D  | 29               | 100                | 256              |
| 1E  | 30               | 200                | 512              |
| 1F  | 31               | 300                | 768              |
| 20  | 32               | 400                | 1024             |
| .   |                  | 500                | 1280             |
| .   |                  | 600                | 1536             |
| .   |                  | 700                | 1792             |
| 30  | 48               | 800                | 2048             |
| .   |                  | 900                | 2304             |
| .   |                  | A00                | 2560             |
| .   |                  | B00                | 2816             |
| 40  | 64               | C00                | 3072             |
| .   |                  | D00                | 3328             |
| .   |                  | E00                | 3584             |
| .   |                  | F00                | 3840             |

| Hexade-<br>ci mal<br>Val ue | Equal s<br>Deci mal : | Hexade-<br>ci mal<br>Val ue: | Equal s<br>Deci mal : |
|-----------------------------|-----------------------|------------------------------|-----------------------|
| <b>50</b>                   | <b>80</b>             | <b>1000</b>                  | <b>4096</b>           |
| .                           |                       | <b>2000</b>                  | <b>8192</b>           |
| .                           |                       | <b>3000</b>                  | <b>12288</b>          |
| .                           |                       | <b>4000</b>                  | <b>16384</b>          |
| <b>60</b>                   | <b>96</b>             | <b>5000</b>                  | <b>20480</b>          |
| .                           |                       | <b>6000</b>                  | <b>24576</b>          |
| .                           |                       | <b>7000</b>                  | <b>28672</b>          |
| .                           |                       | <b>8000</b>                  | <b>32768</b>          |
| <b>70</b>                   | <b>112</b>            | <b>9000</b>                  | <b>36864</b>          |
| .                           |                       | <b>A000</b>                  | <b>40960</b>          |
| .                           |                       | <b>B000</b>                  | <b>45056</b>          |
| .                           |                       | <b>C000</b>                  | <b>49152</b>          |
| .                           |                       | <b>D000</b>                  | <b>53248</b>          |
| .                           |                       | <b>E000</b>                  | <b>57344</b>          |
| .                           |                       | <b>F000</b>                  | <b>61440</b>          |
| .                           |                       | <b>FFFF</b>                  | <b>65535</b>          |

# 14 Appendix H - Key Scan Codes

| Keytop     | Legend | Scancode |
|------------|--------|----------|
| ESC        |        | 01       |
| 1/!        |        | 02       |
| 2/@        |        | 03       |
| 3/#        |        | 04       |
| 4/\$       |        | 05       |
| 5/%        |        | 06       |
| 6/^        |        | 07       |
| 7/&        |        | 08       |
| 8/*        |        | 09       |
| 9/(        |        | 0A       |
| 0/)        |        | 0B       |
| - / _      |        | 0C       |
| = / +      |        | 0D       |
| BACKSPACE  |        | 0E       |
| TAB        |        | 0F       |
| Q          |        | 10       |
| W          |        | 11       |
| E          |        | 12       |
| R          |        | 13       |
| T          |        | 14       |
| Y          |        | 15       |
| U          |        | 16       |
| I          |        | 17       |
| O          |        | 18       |
| P          |        | 19       |
| [ / {      |        | 1A       |
| ] / }      |        | 1B       |
| ENTER      |        | 1C       |
| CTRL       |        | 1D       |
| A          |        | 1E       |
| S          |        | 1F       |
| D          |        | 20       |
| F          |        | 21       |
| G          |        | 22       |
| H          |        | 23       |
| J          |        | 24       |
| K          |        | 25       |
| L          |        | 26       |
| ; / :      |        | 27       |
| ' / "      |        | 28       |
| ' / ~      |        | 29       |
| Left SHIFT |        | 2A       |
| /          |        | 2B       |
| Z          |        | 2C       |
| X          |        | 2D       |
| C          |        | 2E       |
| V          |        | 2F       |
| B          |        | 30       |
| N          |        | 31       |

| Keytop Legend         | Scancode  |
|-----------------------|-----------|
| <b>M</b>              | <b>32</b> |
| <b>, /&lt;</b>        | <b>33</b> |
| <b>. /&gt;</b>        | <b>34</b> |
| <b>//?</b>            | <b>35</b> |
| <b>Right SHIFT</b>    | <b>36</b> |
| <b>*/PRTSC</b>        | <b>37</b> |
| <b>ALT</b>            | <b>38</b> |
| <b>SPACEBAR</b>       | <b>39</b> |
| <b>CAPS LOCK</b>      | <b>3A</b> |
| <b>F1</b>             | <b>3B</b> |
| <b>F2</b>             | <b>3C</b> |
| <b>F3</b>             | <b>3D</b> |
| <b>F4</b>             | <b>3E</b> |
| <b>F5</b>             | <b>3F</b> |
| <b>F6</b>             | <b>40</b> |
| <b>F7</b>             | <b>41</b> |
| <b>F8</b>             | <b>42</b> |
| <b>F9</b>             | <b>43</b> |
| <b>F10</b>            | <b>44</b> |
| <b>NUM LOCK</b>       | <b>45</b> |
| <b>SCROLL LOCK</b>    | <b>46</b> |
| <b>7/HOME</b>         | <b>47</b> |
| <b>8/CURSOR UP</b>    | <b>48</b> |
| <b>9/PGUP</b>         | <b>49</b> |
| <b>-</b>              | <b>4A</b> |
| <b>4/CURSOR LEFT</b>  | <b>4B</b> |
| <b>5</b>              | <b>4C</b> |
| <b>6/CURSOR RIGHT</b> | <b>4D</b> |
| <b>+</b>              | <b>4E</b> |
| <b>1/END</b>          | <b>4F</b> |
| <b>2/CURSOR DOWN</b>  | <b>50</b> |
| <b>3/PGDN</b>         | <b>51</b> |
| <b>0/INS</b>          | <b>52</b> |
| <b>./DEL</b>          | <b>53</b> |

## 15 Appendix I - Characters Recognized by GW-BASIC

The GW-BASIC character set includes all characters that are legal in GW-BASIC commands, statements, functions, and variables. The set comprises alphabetic, numeric, and special characters.

The alphabetic characters in GW-BASIC are the uppercase and lowercase letters of the alphabet.

The numeric characters in GW-BASIC are the digits 0 through 9.

The following special characters and terminal keys are recognized by GW-BASIC:

| Character | Description  |
|-----------|--|
| Blank     | .  |
| =         | Equal sign or assignment symbol.   |
| +         | Plus sign or string concatenation.   |
| -         | Minus sign.  |
| *         | Asterisk or multiplication symbol.   |
| /         | Slash or division symbol.  |
| ^         | Caret, exponentiation symbol, or CTRL key.   |
| (         | Left parenthesis.  |
| )         | Right parenthesis.   |
| %         | Percent or integer declaration.  |
| #         | Number sign or double-precision declaration.   |
| \$        | Dollar sign or string declaration.   |
| !         | Exclamation point or single-precision declaration.   |
| [         | Left bracket.  |
| ]         | Right bracket.   |
| ,         | Comma.   |
| " "       | Double quotation marks or string delimiter.  |
| .         | Period, dot, or decimal point.   |
| '         | Single quotation mark, apostrophe, or remark indicator.  |
| ;         | Semicolon or carriage return suppressor.   |
| :         | Colon or line statement delimiter.   |
| &         | Ampersand or descriptor for hexadecimal and octal number conversion.   |
| ?         | Question mark.   |
| <         | Less than symbol.  |
| >         | Greater than symbol.   |
| \         | Backslash or integer division symbol.  |
| @         | "At" sign.   |
| _         | Underscore.  |
| BACKSPACE | Deletes last character typed.  |
| ESC       | Erases the current logical line from the screen.   |
| TAB       | Moves print position to next tab stop. Tab stops are every eight columns.  |
| CURSOR    | Moves cursor to next physical line.  |
| RETURN    | Terminates input to a line and moves cursor to beginning of the next line, or executes statement in direct mode. |



# 16 Glossary

## abend

An acronym for abnormal end of task. An abend is the termination of computer processing on a job or task prior to its completion because of an error condition that cannot be resolved by programmed recovery procedures.

## access

The process of seeking, reading, or writing data on a storage unit.

## access methods

Techniques and programs used to move data between main memory and input/output devices.

## accuracy

The degree of freedom from error. Accuracy is often confused with precision, which refers to the degree of preciseness of a measurement.

## acronym

A word formed by the initial letters of words or by initial letters plus parts of several words. Acronyms are widely used in computer technology. For example, COBOL is an acronym for COmmon Business Oriented Language.

## active partition

A section of the computer's memory that houses the operating system being used.

## address

A name, label, or number identifying a register, location or unit where information is stored.

## algebraic language

A language whose statements are structured to resemble the structure of algebraic expression. Fortran is a good example of an algebraic language.

## algorithm

A set of well-defined rules or procedures to be followed in order to obtain the solution of a problem in a finite number of steps. An algorithm can involve arithmetic, algebraic, logical and other types of procedures and instructions. An algorithm can be simple or complex. However, all algorithms must produce a solution within a finite number of steps. Algorithms are fundamental when using a computer to solve problems, because the computer must be supplied with a specific set of instructions that yields a solution in a reasonable length of time.

al ph a b e t i c

Data representation by alphabetical characters in contrast to numerical; the letters of the alphabet.

al ph a n u m e r i c

A contraction of the words alphabetic and numeric; a set of characters including letters, numerals, and special symbols.

ap p l i c a t i o n

The system or problem to which a computer is applied. Reference is often made to an application as being either of the computational type, in which arithmetic computations predominate, or of the data processing type, in which data handling operations predominate.

ap p l i c a t i o n   p r o g r a m

A computer program designed to meet specific user needs.

ar g u m e n t

1. A type of variable whose value is not a direct function of another variable. It can represent the location of a number in a mathematical operation, or the number with which a function works to produce its results.
2. A known reference factor that is required to find a desired item (function) in a table. For example, in the square root function  $\text{SQRT}(X)$ ,  $X$  is the argument. The value of  $X$  determines the square root value returned by this function.

ar r a y

1. An organized collection of data in which the argument is positioned before the function.
2. A group of items or elements in which the position of each item or element is significant. A multiplication table is a good example of an array.

A S C I I

Acronym for American Standard Code for Information Interchange. ASCII is a standardized 8-bit code used by most computers for interfacing.

ASCII was developed by the American National Standards Institute (ANSI). It uses 7 binary bits for information and the 8th bit for parity purposes.

a s s e m b l e r

A computer program that produces a machine-language program which may then be directly executed by the computer.

## assembly language

A symbolic language that is machine-oriented rather than problem-oriented. A program in an assembly language is converted by an assembler to a machine-language program. Symbols representing storage locations are converted to numerical storage locations; symbolic operation codes are converted to numeric operation codes.

## asynchronous

1. Not having a regular time or clocked relationship. See synchronous.
2. A type of computer operation in which a new instruction is initiated when the former instruction is completed. Thus, there is no regular time schedule, or clock, with respect to instruction sequence. The current instruction must be complete before the next is begun, regardless of the length of time the current instruction takes.

## asynchronous communication

A way of transmitting data serially from one device to another, in which each transmitted character is preceded by a start bit and followed by a stop bit. This is also called start/stop transmission.

## back-up

1. A second copy of data on a diskette or other medium, ensuring recovery from loss or destruction of the original media.
2. On-site or remote equipment available to complete an operation in the event of primary equipment failure.

## BASIC

Acronym for Beginner's All-purpose Symbolic Instruction Code. BASIC is a computer programming language developed at Dartmouth College as an instructional tool in teaching fundamental programming concepts. This language has since gained wide acceptance as a time-sharing language and is considered one of the easiest programming languages to learn.

## batch processing

A method of operating a computer so that a single program or set of related programs must be completed before the next type of program is begun.

## baud

A unit of measurement of data processing speed. The speed in bauds is the number of signal elements per second. Since a signal element can represent more than one bit, baud is not synonymous with bits-per-second. Typical baud rates are 110, 300, 1200, 2400, 4800, and 9600.

## binary

1. A characteristic or property involving a choice or condition in which there are two possibilities.

2. A numbering system which uses 2 as its base instead of 10 as in the decimal system. The binary system uses only two digits, 0 and 1, in its written form.
3. A device whose design uses only two possible states or levels to perform its functions. A computer executes programs in binary form.

binary digit

A quantity which is expressed in the binary digits of 0 and 1.

bit

A contraction of "binary digit". A bit can either be 0 or 1, and is the smallest unit of information recognizable by a computer.

block

An amount of storage space or data, of arbitrary length, usually contiguous, and often composed of several similar records, all of which are handled as a unit.

boolean logic

A field of mathematical analysis in which comparisons are made. A programmed instruction can cause a comparison of two fields of data, and modify one of those fields or another field as a result of comparison. This system was formulated by British mathematician George Boole (1815-1864). Some boolean operators are OR, AND, NOT, XOR, EQV, and IMP.

boot

A machine procedure that allows a system to begin operations at the desired level by means of its own initiation. The first few instructions are loaded into a computer from an input device. These instructions allow the rest of the system to be loaded. The word boot is abbreviated from the word bootstrap.

bps

Bits per second.

buffer

A temporary storage area from which data is transferred to or from various devices.

built-in clock

A real-time clock that lets your programs use the time of day and date. Built into MS-DOS, it lets you set the timing of a program. It can be used to keep a personal calendar, and it automatically measures elapsed time.

byte

An element of data which is composed of eight data bits plus a parity bit, and represents either one alphabetic or special character, two decimal digits, or eight binary bits. Byte is also used to refer to a sequence of eight binary digits handled as a unit. It is usually encoded in the ASCII format.

calculation

A series of numbers and mathematical signs that, when entered into a computer, is executed according to a series of instructions.

central processor (CPU)

The heart of the computer system, where data is manipulated and calculations are performed. The CPU contains a control unit to interpret and execute the program and an arithmetic-logic unit to perform computations and logical processes. It also routes information, controls input and output, and temporarily stores data.

chain ing

The use of a pointer in a record to indicate the address of another record logically related to the first.

character

Any single letter of the alphabet, numeral, punctuation mark, or other symbol that a computer can read, write, and store. Character is synonymous with the term byte.

COBOL

Acronym for COmmon Business-Oriented Language, a computer language suitable for writing complicated business applications programs. It was developed by CODASYL, a committee representing the U. S. Department of Defense, certain computer manufacturers, and major users of data processing equipment. COBOL is designed to express data manipulations and processing problems in English narrative form, in a precise and standard manner.

code

1. To write instructions for a computer system
2. To classify data according to arbitrary tables
3. To use a machine language
4. To program

command

A pulse, signal, word, or series of letters that tells a computer to start, stop, or continue an operation in an instruction. Command is often used

incorrectly as a synonym for instruction.

compatible

A description of data, programs or equipment that can be used between different kinds of computers or equipment.

compiler

A computer program that translates a program written in a problem-oriented language into a program of instructions similar to, or in, the language of the computer.

computer network

A geographically dispersed configuration of computer equipment connected by communication lines and capable of load sharing, distributive processing, and automatic communication between the computers within the network.

concatenate

To join together data sets, such as files, in a series to form one data set, such as one new file. The term concatenate literally means "to link together." A concatenated data set is a collection of logically connected data sets.

configuration

In hardware, a group of interrelated devices that constitute a system. In software, the total of the software modules and their interrelationships.

constant

A never-changing value or data item.

coprocessor

A microprocessor device connected to a central microprocessor that performs specialized computations (such as floating-point arithmetic) much more efficiently than the CPU alone.

cursor

A blinking line or box on a computer screen that indicates the next location for data entry.

data

A general term used to signify all the basic information elements that can be produced or processed by a computer. See information.

data element

The smallest named physical data unit.

data file

A collection of related data records organized in a specific manner. Data files contain computer records which contain information, as opposed to containing data handling information or a program.

debug

The process of checking the logic of a computer program to isolate and remove mistakes from the program or other software.

default

An action or value that the computer automatically assumes, unless a different instruction or value is given.

delimiter

To establish parameters; to set a minimum and a maximum.

delimiter

A character that marks the beginning or end of a unit of data on a storage medium. Commas, semi-colons, periods, and spaces are used as delimiters to separate and organize items of data.

detail file

A data file composed of records having similar characteristics, but containing data which is relatively changeable by nature, such as employee weekly payroll data. Compare to master file.

device

A piece of hardware that can perform a specific function. A printer is an example of a device.

Cursor-End-of-File Mark (EOF)

diagnostic programs

Special programs used to align equipment or isolate equipment malfunctions.

directory

A table that gives the name, location, size, and the creation or last revision date for each file on the storage media.

diskette

A flat, flexible platter coated with magnetic material, enclosed in a protective envelope, and used for storage of software and data.

Disk Operating System

A collection of procedures and techniques that enable the computer to operate using a disk drive system for data entry and storage. Disk Operating System is usually abbreviated to DOS.

DOS

The acronym for Disk Operating System. DOS rhymes with "boss."

double-density

A type of diskette that has twice the storage capacity of standard single-density diskettes.

double-precision

The use of two computer words to represent each number. This technique allows the use of twice as many digits as are normally available and is used when extra precision is needed in calculations.

double-sided

A term that refers to a diskette that can contain data on both surfaces of the diskette.

drive

A device that holds and manipulates magnetic media so that the CPU can read data from or write data to them.

end-of-file mark (EOF)

A symbol or machine equivalent that indicates that the last record of a file has been read.

erase

To remove or replace magnetized spots from a storage medium.

error message

An audible or visual indication of hardware or software malfunction or of an illegal data-entry attempt.

execute

To carry out an instruction or perform a routine.



exponent

A symbol written above a factor and on the right, telling how many times the factor is repeated. In the example of  $A^2$ , A is the factor and 2 is the exponent.  $A^2$  means A times A ( $A \times A$ ).

extension

A one-to-three-character set that follows a filename. The extension further defines or clarifies the filename. It is separated from the filename by a period(.).

field

An area of a record that is allocated for a specific category of data.

file

A collection of related data or programs that is treated as a unit by the computer.

file protection

The devices or procedures that prevent unintentional erasure of data on a storage device, such as a diskette.

file structure

A conceptual representation of how data values, records, and files are related to each other. The structure usually implies how the data is stored and how the data must be processed.

filename

The unique name, usually assigned by a user, which is used to identify one file for all subsequent operations that use that file.

fixed disk

A hard disk enclosed in a permanently-sealed housing that protects it from environmental interference. Used for storage of data.

floating-point arithmetic

A method of calculation in which the computer or program automatically records, and accounts for, the location of the radix point. The programmer need not consider the radix location.

floating-point routine

A set of program instructions that permits a floating-point mathematics operation in a computer which lacks the feature of automatically accounting for the radix point.

format

A predetermined arrangement of data that structures the storage of information.

nation on an external storage device.

function

A computer action, as defined by a specific instruction. Some GW-BASIC functions are COS, EOF, INSTR, LEFT\$, and TAN.

function keys

Specific keys on the keyboard that, when pressed, instruct the computer to perform a particular operation. The function of the keys is determined by the applications program being used.

GIGO

An informal term that indicates sloppy data processing; an acronym for Garbage In Garbage Out. The term GIGO is normally used to make the point that if the input data is bad (garbage in) then the output data will also be bad (garbage out).

global search

Used in reference to a variable (character or command), a global search causes the computer to locate all occurrences of that variable.

graphics

A hardware/software capability to display objects in pictures, rather than words, usually on a graphic (CRT) display terminal with line-drawing capability and permitting interaction, such as the use of a light pen.

hard copy

A printed copy of computer output in a readable form, such as reports, checks, or plotted graphs.

hardware

The physical equipment that comprises a system.

hexadecimal

A number system with a base, or radix, of 16. The symbols used in this system are the decimal digits 0 through 9 and six additional digits which are generally represented as A, B, C, D, E, and F.

hidden files

Files that cannot be seen during normal directory searches.

hierarchical directories

See tree-structured directories.

housekeeping functions

Routine operations that must be performed before the actual processing

begins or after it is complete.

#### information

Facts and knowledge derived from data. The computer operates on and generates data. The meaning derived from the data is information. That is, information results from data; the two words are not synonymous, although they are often used interchangeably.

#### interpreter

A program that reads, translates and executes a user's program, such as one written in the BASIC language, one line at a time. A compiler, on the other hand, reads and translates the entire user's program before executing it.

#### input

1. The process or device concerning the entry of data into a computer.
2. Actual data being entered into a computer.

#### input/output

A general term for devices that communicate with a computer. Input/output is usually abbreviated as I/O.

#### instruction

A program step that tells the computer what to do next. Instruction is often used incorrectly as a synonym for command.

#### integer

A complete entity, having no fractional part. The whole or natural number. For example, 65 is an integer; 65.1 is not.

#### integrated circuit

A complete electronic circuit contained in a small semiconductor component.

#### interface

An information interchange path that allows parts of a computer, computers, and external equipment (such as printers, monitors, or modems), or two or more computers to communicate or interact.

#### I/O

The acronym for input/output.

#### job

A collection of tasks viewed by the computer as a unit.

## K

The symbol signifying the quantity  $2^{10}$ , which is equal to 1024. K is sometimes confused with the symbol k, (kilo) which is equal to 1000.

## logarithm

A logarithm of a given number is the value of the exponent indicating the power required to raise a specified constant, known as the base, to

produce that given number. That is, if B is the base, N is the given number and L is the logarithm, then  $B^L = N$ . Since  $10^3 = 1000$ , the logarithm to the base 10 of 1000 is 3.

## loop

A series of computer instructions that are executed repeatedly until a desired result is obtained or a predetermined condition is met. The ability to loop and reuse instructions eliminates countless repetitious instructions and is one of the most important attributes of stored programs.

## M

The symbol signifying the quantity 1,000,000 ( $10^6$ ). When used to denote storage, it more precisely refers to 1,048,576 ( $2^{20}$ ).

## mantissa

The fractional or decimal part of a logarithm of a number. For example, the logarithm of 163 is 2.212. The mantissa is 0.212, and the characteristic is 2.0.

In floating-point numbers, the mantissa is the number part. For example, the number 24 can be written as  $24.2 \times 10^2$  where 24.2 is the mantissa and 2 is the exponent. The floating-point number is read as  $.24 \times 10^2$ , or  $2.4 \times 10^1$ .

## master file

A data file composed of records having similar characteristics that rarely change. A good example of a master file would be an employee name and address file that also contains social security numbers and hiring dates.

## media

The plural of medium.

## medium

The physical material on which data is recorded and stored. Magnetic tape, punched cards, and diskettes are examples of media.

## memory

The high-speed work area in the computer where data can be held, copied, and retrieved.

menu

A list of choices from which an operator can select a task or operation to be performed by the computer.

microprocessor

A semiconductor central processing unit (CPU) in a computer.

modem

Acronym for modulator demodulator. A modem converts data from a computer to analog signals that can be transmitted through telephone lines, or converts the signals from telephone lines into a form the computer can use.

MS-DOS

Acronym for Microsoft Disk Operating System.

nested programs or subroutines

A program or subroutine that is incorporated into a larger routine to permit ready execution or access of each level of the routine. For example, nesting loops involves incorporating one loop of instructions into another loop.

null

Empty or having no members. This is in contrast to a blank or zero, which indicates the presence of no information. For example, in the number 540, zero contains needed information.

numeric

A reference to numerals as opposed to letters or other symbols.

octal number system

A representation of values or quantities with octal numbers. The octal number system uses eight digits: 0, 1, 2, 3, 4, 5, 6, and 7, with each position in an octal numeral representing a power of 8. The octal system is used in computing as a simple means of expressing binary quantities.

operand

A quantity or data item involved in an operation. An operand is usually designated by the address portion of an instruction, but it may also be a result, a parameter, or an indication of the name or location of the next instruction to be executed.

operating system

An organized group of computer instructions that manage the overall operation of the computer.

operator

A symbol indicating an operation and itself the subject of the operation. It indicates the process that is being performed. For example, + is addition, - is subtraction, X is multiplication, and / is division.

option

An add-on device that expands a system's capabilities.

output

Computer results, or data that has been processed.

parallel output

The method by which all bits of a binary word are transmitted simultaneously.

parameter

A variable that is given a value for a specific program or run. A definable characteristic of an item, device, or system.

parity

An extra-bit of code that is used to detect data errors in memory by making the sum of the active bit in a data word either an odd or an even number.

partition

An area on a fixed disk set aside for a specific purpose, such as a location for an operating system.

peripheral

An external input/output, or storage device.

pixel

The acronym for picture element. A pixel is a single dot on a monitor that can be addressed by a single bit.

port

The entry channel to and from the central computer for connection of a communications line or other peripheral device.

power

The functional area of a system that transforms an external power source into internal DC supply voltage.

program

A series of instructions or statements in a form acceptable to a computer,

designed to cause the computer to execute a series of operations. Computer programs include software such as operating systems, assemblers, compilers, interpreters, data management systems, utility programs, sort-merge programs, and maintenance/diagnostic programs, as well as application programs such as payroll, inventory control, and engineering analysis programs.

prompt

A character or series of characters that appear on the screen to request input from the user.

RAM

Acronym for random-access memory.

radian

The natural unit of measure of the angle between two intersecting half-lines on the angles from one half-line to another intersecting half-line. It is the angle subtended by an arc of a circle equal in length to the radius of the circle. As the circumference of a circle is equal to  $2\pi$  times its radius, the number of radians in an angle of  $360^\circ$  or in a complete turn is  $2\pi$ .

radix

A number that is arbitrarily made the fundamental number of a system of numbers; a base. Thus, 10 is the radix, or base, of the common system of logarithms, and also of the decimal system of enumeration.

random-access memory

The system's high-speed work area that provides access to memory storage locations by using a system of vertical and horizontal coordinates. The computer can write information into or read information from the random access memory. Random-access memory is often called RAM.

raster unit

On a graphic display screen, a raster unit is the horizontal or vertical distance between two adjacent addressable points on the screen.

read-only memory

A type of memory that contains permanent data or instructions. The computer can read from but not write to the read-only memory. Read-only memory is often called ROM.

real number

An ordinary number, either rational or irrational; a number in which there is no imaginary part, a number generated from the single unit, 1; any point in a continuum of natural numbers filled in with all rationals and all irrationals and extended indefinitely, both positive and negative.

real time

1. The actual time required to solve a problem.
2. The process of solving a problem during the actual time that a related physical process takes place so that results can be used to guide the physical process.

remote

A term used to refer to devices that are located at sites away from the central computer.

reverse video

A display of characters on a background, opposite of the usual display.

ROM

Acronym for read-only memory.

RS-232

A standard communications interface between a modem and terminal devices that complies with EIA Standard RS-232.

serial output

Sending only one bit at a time to and from interconnected devices.

single-density

The standard recording density of a diskette. Single-density diskettes can store approximately 3400 bits per inch (bpi).

single-precision value

The number of words or storage positions used to denote a number in a computer. Single-precision arithmetic is the use of one word per number, double-precision arithmetic is the use of two words per number, and so on. For variable word-length computers, precision is the number of digits used to denote a number. The higher the precision, the greater the number of decimal places that can be carried.

single-sided

A term used to describe a diskette that contains data on one side only.

software

A string of instructions that, when executed, direct the computer to perform certain functions.

stack architecture

An architecture wherein any portion of the external memory can be used as a last-in, first-out stack to store/retrieve the contents of the accumulator,



the flags, or any of the data registers. Many units contain a 16-bit stack pointer to control the addressing of this external stack. One of the major advantages of the stack is that multiple-level interrupts can be handled easily, since complete system status can be saved when an interrupt occurs and then be restored after the interrupt. Another major advantage is that almost unlimited subroutine nesting is possible.

statement

A high-level language instruction to the computer to perform some sequence of operations.

synchronous

A type of computer operation in which the execution of each instruction or each event is controlled by a clock signal: evenly spaced pulses that enable the logic gates for the execution of each logic step. A synchronous operation can cause time delays by causing waiting for clock signals although all other signals at a particular logic gate were available. See asynchronous.

switch

An instruction, added to a command, that designates a course of action, other than default, for the command process to follow.

syntax

Rules of statement structure in a programming language.

system

A collection of hardware, software, and firmware that is interconnected to operate as a unit.

task

A machine run; a program in execution.

toggle

Alternation of function between two stable states.

track

A specific area on a moving-storage medium, such as a diskette, disk, or tape cartridge, that can be accessed by the drive heads.

tree-structured directory

A file-organization structure, consisting of directories and subdirectories that, when diagrammed, resembles a tree.

truncation

To end a computation according to a specified rule; for example, to drop numbers at the end of a line instead of rounding them off, or to drop characters at the end of a line when a file is copied.

upgrade

To expand a system by installing options or using revised software.

utility function

Computer programs, dedicated to one particular task, that are helpful in using the computer. For example, FDISK, for setting up partitions on the fixed disk.

variable

A quantity that can assume any of a set of values as a result of processing data.

volume label

The name for the contents of a diskette or a partition on a fixed disk.

word

The set of bits comprising the largest unit that the computer can handle in a single operation.

write-protect notch

A cut-out opening in the sealed envelope of a diskette that, when covered, prevents writing or adding text to the diskette, but allows information to be read from the diskette.

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# **Microsoft (R) GW-BASIC Interpreter User's Reference**

Microsoft Corporation

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# Introduction

This manual is an alphabetical reference to GW-BASIC instructions: statements, functions, commands, and variables.

The name and type of each instruction is listed at the top of the page, and is followed by:

- Purpose:** The purpose of the instruction
- Syntax:** The complete notation of the instruction
- Comments:** Pertinent information about the instruction, and what happens when it is encountered by GW-BASIC
- Examples:** An illustration of the instruction as it might appear in a program
- Notes:** Any special information about the instruction

## ABS Function

### Purpose:

To return the absolute value of the expression *n*.

### Syntax:

**ABS(*n*)**

### Comments:

***n*** must be a numeric expression.

### Examples:

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

Prints 35 as the result of the action.

# ASC Function

## Purpose:

To return a numeric value that is the ASCII code for the first character of the string **x\$**.

## Syntax:

**ASC(x\$)**

## Comments:

If **x\$** is null, an "Illegal Function Call" error is returned.

If **x\$** begins with an uppercase letter, the value returned will be within the range of 65 to 90.

If **x\$** begins with a lowercase letter, the range is 97 to 122.

Numbers 0 to 9 return 48 to 57, sequentially.

See the **CHR\$** function for ASCII-to-string conversion.

See Appendix C in the GW-BASIC User's Guide for ASCII codes.

## Examples:

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

84 is the ASCII code for the letter T.



# ATN Function

## Purpose:

To return the arctangent of x, when x is expressed in radians.

## Syntax:

**ATN(x)**

## Comments:

The result is within the range of  $-\pi/2$  to  $\pi/2$ .

The expression **x** may be any numeric type. The evaluation of **ATN** is performed in single precision unless the **/d** switch is used when GW-BASIC is executed.

To convert from degrees to radians, multiply by  $\pi / 180$ .

## Examples:

```
10 INPUT X
20 PRINT ATN(X)
RUN
? 3
1. 249046
Ok
```

Prints the arctangent of 3 radians (1.249046).

# AUTO Command

## Purpose:

To generate and increment line numbers automatically each time you press the RETURN key.

## Syntax:

```
AUTO [line number][, [increment]]  
AUTO .[, [increment]]
```

## Comments:

**AUTO** is useful for program entry because it makes typing line numbers unnecessary.

**AUTO** begins numbering at *line number* and increments each subsequent line number by *increment*. The default for both values is 10.

The period (.) can be used as a substitute for *line number* to indicate the current line.

If line number is followed by a comma, and *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 appears after the number to warn that any input will replace the existing line. However, pressing RETURN immediately after the asterisk saves the line and generates the next line number.

**AUTO** is terminated by entering CTRL-BREAK or CTRL-C. GW-BASIC will then return to command level.

## Note

The line in which CTRL-BREAK or CTRL-C is entered is not saved. To be sure that you save all desired text, use CTRL-BREAK and CTRL-C only on lines by themselves.

## Examples:

```
AUTO 100, 50
```

Generates line numbers 100, 150, 200, and so on.

```
AUTO
```

Generates line numbers 10, 20, 30, 40, and so on.

# BEEP Statement

## Purpose:

To sound the speaker at 800 Hz (800 cycles per second) for one-quarter of a second.

## Syntax:

**BEEP**

## Comments:

**BEEP**, CTRL-G, and **PRINT CHR\$(7)** have the same effect.

## Examples:

```
2340 IF X>20 THEN BEEP
```

If X is out of range, the computer beeps.

# BLOAD Command

## Purpose:

To load an image file anywhere in user memory.

## Syntax:

**BLOAD** *filename*[ , *offset*]

## Comments:

*filename* is a valid string expression containing the device and filename.

*offset* is a valid numeric expression within the range of 0 to 65535. This is the offset into the segment, declared by the last **DEF SEG** statement, where loading is to start.

If offset is omitted, the offset specified at **BSAVE** is assumed; that is, the file is loaded into the same location it was saved from.

## Note

**BLOAD** does not perform an address range check. It is possible to **BLOAD** anywhere in memory. You must not **BLOAD** over the GW-BASIC stack space, a GW-BASIC program, or the GW-BASIC variable area.

While **BLOAD** and **BSAVE** are useful for loading and saving machine language programs, they are not restricted to them. The **DEF SEG** statement lets you specify any segment as the source or target for **BLOAD** and **BSAVE**. For example, this allows the video screen buffer to be read from or written to the diskette. **BLOAD** and **BSAVE** are useful in saving and displaying graphic images.

## Examples:

```
10 DEF SEG=&HB800
20 BLOAD"PICTURE", 0
```

The **DEF SEG** statement in line 10 points the segment at the screen buffer.

The **DEF SEG** statement in line 10 and the offset of 0 in line 20 guarantee that the correct address is used.

The **BLOAD** command in line 20 loads the file named picture into the screen buffer.

## Note

The **BSAVE** example in the next section illustrates how the file named picture is saved.

# BSAVE Command

## Purpose:

To save portions of user memory on the specified device.

## Syntax:

**BSAVE** *filename, offset, length*

## Comments:

*filename* is a valid string expression containing the filename.

*offset* is a valid numeric expression within the range of 0 to 65535. This is the offset into the segment, declared by the last **DEF SEG**, where saving is to start.

*length* is a valid numeric expression within the range of 0 to 65535, specifying the length of the memory image to be saved.

If *filename* is less than one character, a "Bad File Number" error is issued and the load is aborted.

Execute a **DEF SEG** statement before the **BSAVE**. The last known **DEF SEG** address is always used for the save.

The **DEF SEG** statement must be used to set up the segment address to the start of the screen buffer. An offset of 0 and a length of 16384 specify that the entire 16K screen buffer is to be saved.

## Examples:

```
10 DEF SEG=&HB800
20 BSAVE"PICTURE", 0, 16384
```

The **DEF SEG** statement in line 10 points the segment at the screen buffer.

The **BSAVE** command in line 20 saves the screen buffer in the file named picture.

# CALL Statement

## Purpose:

To call an assembly (or machine) language subroutine.

## Syntax:

**CALL** *numvar* [ (*variables*) ]

## Comments:

*numvar* is the starting point in memory of the subroutine being called as an offset into the current segment.

*variables* are the variables or constants, separated by commas and enclosed in parentheses, that are to be passed to the routine.

The **CALL** statement is recommended for interfacing assembly language programs with GW-BASIC. Although the **USR** function may also be used, **CALL** is compatible with more languages, produces a more readable source code, and can pass multiple arguments.

Invocation of the **CALL** statement causes the following to occur:

- o Each parameter location in the variable is pushed onto the stack. The parameter location is a 2-byte offset into GW-BASIC's data segment.
- o The return address code segment (CS) and the offset are pushed onto the stack.
- o Control is transferred to the user routine by the segment address given in the last **DEF SEG** statement and the offset given in the variable name.
- o The user routine now has control. Parameters may be referenced by moving the stack pointer (SP) to the base pointer (BP) and adding a positive offset to BP.
- o The called routine may destroy the contents of any registers.
- o The called program must know how many parameters were passed. Parameters are referenced by adding a positive offset to BP, assuming the called routine moved the current stack pointer into BP (that is **MOV BP, SP**).
- o The called program must know the variable type for numeric parameters passed.
- o The called routine must do a **RET n**, where n is the number of parameters in the variable times 2. This is necessary in order to adjust the stack to the point at the start of the calling sequence.
- o Values are returned to GW-BASIC by including in the argument list the name of the variable that is to receive the result.

- o If the argument is a string, the parameter offset points to three bytes called the string descriptor. Byte 0 of the string descriptor contains the length of the string (0 to 255). Bytes 1 and 2, respectively, are the lower- and upper-eight bits of the string starting address in the string space.
- o If the argument is a string literal in the program, the string descriptor points to program text. Be careful not to alter or destroy a program this way. To avoid unpredictable results, add +"" to the string literal in the program, as in the following:

```
20 AS="BASIC" + ""
```

This forces the string literal to be copied into the string space. Now the string may be modified without affecting the program.

## Note

Strings may be altered by user routines, but their length must not be changed. GW-BASIC cannot correctly erase strings if their lengths are modified by external routines.

For more information on the **CALL** statement and **USR** function, see Appendix D in the GW-BASIC User's Guide.

## Example 1:

```
100 DEF SEG=&H2000
110 ARK=0
120 CALL ARK(A, BS, C)
```

Line 100 sets the segment to hex 2000. ARK is set to zero so that the call to ARK executes the subroutine at location 2000:0.

## Example 2:

The following sequence of 8086 Assembly Language demonstrates access of the parameters passed and stored in variable C:

```
PUSH BP
MOV BP, SP ; Gets current stack position in BP.
MOV BX, 8[BP] ; Gets address of B$ descriptor.
MOV CL, [BX] ; Gets length of B$ in CL.
MOV DX, 1[BX] ; Gets address of B$ text in DX.
MOV SI, 10[BP] ; Gets address of A in SI.
MOV DI, 6[BP] ; Gets pointer to C in DI.
MOVSW ; Stores variable A in C.
RET 6 ; Restores stack and returns.
```

**MOVSW** copies only two bytes. This is sufficient if variables A and C are integer. Four bytes must be copied if they are single precision; eight bytes, if they are double precision.

## Example 3:

```
100 DEF SEG=&H2000
110 ACC=&H7FA
120 CALL ACC(A, B$, C)
```

Line 100 sets the segment to hex 2000. The value of variable ACC is added into the address as the low word after the **DEF SEG** value is shifted four bits to the left (this is a function of the microprocessor, not of GW-BASIC). Here, ACC is set to &H7FA, so that the call to ACC executes the subroutine at the location hex 2000:7FA (absolute address hex 207FA).



# CDBL Function

## Purpose:

To convert **x** to a double-precision number.

## Syntax:

**CDBL(x)**

## Comments:

**x** must be a numeric expression.

## Example:

```
10 A=454. 67
20 PRINT A; CDBL(A)
RUN
454. 67 454. 6700134277344
Ok
```

Prints a double-precision version of the single-precision value stored in the variable named A.

The last 11 numbers in the double-precision number have no meaning in this example, since A was previously defined to only two-decimal place accuracy.

## Note

See the **CINT** and **CSNG** functions for converting numbers to integer and single precision, respectively.

# CHAIN Statement

## Purpose:

To transfer control to the specified program and pass (chain) variables to it from the current program.

## Syntax:

```
CHAIN[MERGE] filename [, [line] [, [ALL] [, DELETE range]]]
```

## Comments:

**MERGE** overlays the current program with the called program.

## Note

The called program must be an ASCII file (previously saved with the **a** option) if it is to be merged (see the **MERGE** command).

***filename*** is the name of the program that is called to be chained to. The .BAS extension is assumed unless another is specified.

***line*** is a line number or an expression that corresponds to a line number in the called program. It is the starting point for execution of the called program. For example the following begins execution of PROG1 at line 1000:

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

If line is omitted, execution begins at the first line.

***line*** is not affected by a **RENUM** command. However, the line numbers in the specified range are affected by a **RENUM** command.

**ALL** specifies that every variable in the current program is chained to the called program. For example:

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

If the **ALL** option is omitted, the current program must contain a **COMMON** statement to list the variables that are passed.

**CHAIN** executes a **RESTORE** before it runs the program that it is to be chained to. The **READ** statement then gets the first item in the **DATA** statement. Reading will not resume where it left off in the program that is being chained.

After an overlay is executed and used for a specific purpose, it is usually desirable to delete it so that a new overlay may be brought in. To do this, use the **DELETE** command.

The **CHAIN** statement with the **MERGE** command leaves the files open and preserves the current option base setting.

If the **MERGE** command is omitted, the **OPTION BASE** setting is preserved, and **CHAIN** preserves no variable types or user-defined functions for use by the chained program. That is, any **DEFINT**, **DEFSNG**, **DEFDBL**, **DEFSTR**, or **DEF FN** statement containing shared variables must be restated in the chained program.

When using the merge command, place user-defined functions before any **CHAIN MERGE** statements in the program. Otherwise, they will be undefined after the merge is complete.

## CHDIR Command

### Purpose:

To change from one working directory to another.

### Syntax:

**CHDIR** *pathname*

### Comments:

*pathname* is a string expression of up to 63 characters.

To make sales the working directory on Drive A: and inventory the working directory on Drive B: (assume A: is the default drive), type the following commands:

```
CHDIR "SALES"  
CHDIR "B:INVENTORY"
```

# CHR\$ Function

## Purpose:

To convert an ASCII code to its equivalent character.

## Syntax:

**CHR\$(*n*)**

## Comments:

*n* is a value from 0 to 255.

**CHR\$** is commonly used to send a special character to the terminal or printer. For example, you could send **CHR\$(7)** to sound a beep through the speaker as a preface to an error message, or you could send a form feed, **CHR\$(12)**, to the printer.

See the ASC function for ASCII-to-numeric conversion.

ASCII Codes are listed in Appendix C of the GW-BASIC User's Guide.

## Examples:

```
PRINT CHR$(66);
```

```
B  
Ok
```

This prints the ASCII character code 66, which is the uppercase letter B.

```
PRINT CHR$(13);
```

This command prints a carriage return.

# CINT Function

## Purpose:

To round numbers with fractional portions to the next whole number or integer.

## Syntax:

**CINT(x)**

## Comments:

If **x** is not within the range of -32768 to 32767, an "Overflow" error occurs.

See the **FIX** and **INT** functions, both of which return integers.

## Examples:

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

45.67 is rounded up to 46.

## Note

See the **CDBL** and **CSNG** functions for converting numbers to the double-precision and single-precision data types, respectively.

# CIRCLE Statement

## Purpose:

To draw a circle, ellipse, and angles on the screen during use of the Graphics mode.

## Syntax:

`CIRCLE(xcenter, ycenter) , radius [ , [ color ] [ , [ start ] , [ end ] [ , aspect ] ] ]`

## Comments:

*xcenter* and *ycenter* are the x- and y- coordinates of the center of the ellipse, and *radius* is the radius (measured along the major axis) of the ellipse. The quantities *xcenter* and *ycenter* can be expressions. The center attributes can use either absolute or relative coordinates.

*color* specifies the color of the ellipse. Its value depends on the current screen mode.

See the **COLOR** and **SCREEN** statements for more information on using colors in different screen modes.

In the high-resolution mode, 0 indicates black and 1 indicates white. The default for the high resolution mode is 1.

The *start* and *end* angle parameters are radian arguments between  $-2\pi$  and  $2\pi$  which specify where the drawing of the ellipse is to begin and end. If *start* or *end* is negative, the ellipse is connected to the center point with a line, and the angles are treated as if they are positive (note that this is different from adding  $2\pi$ ).

*aspect* describes the ratio of the x radius to the y radius (x:y). The default aspect ratio depends on the screen mode, but gives a visual circle in either graphics mode, assuming a standard monitor screen aspect ratio of 4:3.

If the aspect ratio is less than 1, then the radius is given in x-pixels. If it is greater than 1, the radius is given in y-pixels.

In many cases, an aspect ratio of 1 gives better ellipses in the medium-resolution mode. This also causes the ellipse to be drawn faster. The start angle may be less than the end angle.

### Example 1:

```
10 SCREEN1: CIRCLE(100, 100), 50
```

Draws a circle of radius 50, centered at graphics points 100x and 100y.

### Example 2:

```
1 ' This will draw 17 ellipses
10 CLS
20 SCREEN 1
30 FOR R=160 TO 0 STEP-10
40 CIRCLE (160, 100), R, , , , 5/18
50 NEXT
```

### Example 3:

```
10 'This will draw 5 spheres
20 GOTO 160
50 IF VERT GOTO 100
60 CIRCLE (X, Y), R, C, , , .07
70 FOR I = 1 TO 5
80 CIRCLE (X, Y), R, C, , , I*.2: NEXT I
90 IF VERT THEN RETURN
100 CIRCLE (X, Y), R, C, , , 1.3
110 CIRCLE (X, Y), R, C, , , 1.9
120 CIRCLE (X, Y), R, C, , , 3.6
130 CIRCLE (X, Y), R, C, , , 9.8
140 IF VERT GOTO 60
150 RETURN
160 CLS: SCREEN 1: COLOR 0, 1: KEY OFF: VERT=0
170 X=160: Y=100: C=1: R=50: GOSUB 50
180 X=30: Y=30: C=2: R=30: GOSUB 50
190 X=30: Y=169: GOSUB 50
200 X=289: Y=30: GOSUB 50
210 X=289: Y=169: GOSUB 50
220 LINE (30, 30) - (289, 169), 1
230 LINE (30, 169) - (289, 30), 1
240 LINE (30, 169) - (289, 30), 1, B
250 Z$=INKEY$: IF Z$="" THEN 250
RUN
```

# CLEAR Command

## Purpose:

To set all numeric variables to zero, all string variables to null, and to close all open files. Options set the end of memory and reserve the amount of string and stack space available for use by GW-BASIC.

## Syntax:

`CLEAR[ , [ expression1] [ , expression2] ]`

## Comments:

*expression1* is a memory location that, if specified, sets the maximum number of bytes available for use by GW-BASIC.

*expression2* sets aside stack space for GW-BASIC. The default is the previous stack space size. When GW-BASIC is first executed, the stack space is set to 512 bytes, or one-eighth of the available memory, whichever is smaller.

GW-BASIC allocates string space dynamically. An "**Out of String Space**" error occurs only if there is no free memory left for GW-BASIC to use.

The **CLEAR** command:

- o Closes all files
- o Clears all **COMMON** and user variables
- o Resets the stack and string space
- o Releases all disk buffers
- o Turns off any sound
- o Resets sound to music foreground
- o Resets **PEN** to *off*
- o Resets **STRIG** to *off*
- o Disables **ON ERROR** trapping



## Examples:

### **CLEAR**

Zeroes variables and nulls all strings.

### **CLEAR 32768**

Zeroes variables, nulls strings, protects memory above 32768, does not change the stack space.

### **CLEAR , , 2000**

Zeroes variables, nulls strings, allocates 2000 bytes for stack space, and uses all available memory in the segment.

### **CLEAR , 32768, 2000**

Zeroes variables, nulls strings, protects memory above 32768, and allocates 2000 bytes for stack space.

# CLOSE Statement

## Purpose:

To terminate input/output to a disk file or a device.

## Syntax:

`CLOSE [ [#] file number [, [#] file number] . . . ]`

## Comments:

*file number* is the number under which the file was opened.

The association between a particular file or device and file number terminates upon execution of a **CLOSE** statement. The file or device may then be reopened using the same or a different file number.

A **CLOSE** statement with no file number specified closes all open files and devices.

A **CLOSE** statement sent to a file or device opened for sequential output writes the final buffer of output to that file or device.

The **END**, **NEW**, **RESET**, **SYSTEM**, or **RUN** and **LOAD** (without **r** option) statements always close all files or devices automatically. **STOP** does not close files.

## Examples:

**250 CLOSE**

This closes all open devices and files.

**300 CLOSE 1, #2, #3**

Closes all files and devices associated with file numbers 1, 2, and 3.

# CLS Statement

## Purpose:

To clear the screen.

## Syntax:

**CLS** [*n*]

## Comments:

*n* is one of the following values:

| Value of n | Effect                                     |
|------------|--|
| 0          | Clears the screen of all text and graphics |
| 1          | Clears only the graphics viewport          |
| 2          | Clears only the text window                |

If the graphics viewport is active, **CLS** without argument clears only the viewport. If the graphics viewport is inactive, **CLS** clears the text window.

If the screen is in alpha mode, the active page is cleared to the currently selected background color (see the **SCREEN** and **COLOR** statements).

If the screen is in graphics mode, the entire screen buffer is cleared to background color.

The screen may also be cleared by pressing CTRL-HOME, or by changing the screen mode with the **SCREEN** or **WIDTH** statements.

**CLS** returns the cursor to the upper-left corner of the screen, and sets the last point referenced to the center of the screen.

If the **VIEW** statement has been used, **CLS** clears only the last viewport specified.

## Examples:

**1 CLS**

This clears the screen.

# COLOR Statement

## Purpose:

To select display colors

## Syntax:

COLOR [ *foreground* ] [ , [ *background* ] [ , *border* ] ]

COLOR [ *background* ] [ , [ *palette* ] ]

COLOR [ *foreground* ] [ , [ *background* ] ]

## Comments:

In general, **COLOR** allows you to select the foreground and background colors for the display. In **SCREEN 0** a border color can also be selected. In **SCREEN 1** no foreground color can be selected, but one of two four-color palettes can be selected for use with graphics statements. The different syntaxes and effects that apply to the various screen modes are described below:

### Mode

### Effect

#### **SCREEN 0**

Modifies the current default text foreground and background colors, and the screen border. The *foreground* color must be an integer expression in the range 0-31. It is used to determine the "foreground" color in text mode, which is the default color of text. Sixteen colors can be selected with the integers 0-15. A blinking version of each color can be selected by adding 16 to the color number; for example, a blinking color 7 is equal to 7 + 16, or 23. Thus, the legal integer range for *foreground* is 0-31.

The *background* color must be an integer expression in the range 0-7, and is the color of the background for each text character. Blinking colors are not permitted.

The *border* color is an integer expression in the range 0-15, and is the color used when drawing the screen border. Blinking colors are not permitted.

If no arguments are provided to **COLOR**, then the default color for background and border is black (**color 0**), and for foreground, is as described in the SCREEN statement reference pages.

**SCREEN 1** In mode 1, the **COLOR** statement has a unique syntax that includes a *palette* argument, which is an odd or even integer expression. This argument determines the set of display colors to use when displaying particular color numbers.

For hardware configurations that do not have an IBM® Enhanced Graphics Adapter (EGA), the default color settings for the *palette* parameter are equivalent to the following:

```
COLOR , 0  ' Same as the next three PALETTE
           ' statements
           ' 1 = green, 2 = red, 3 = yellow
```

```
COLOR , 1  ' Same as the next three PALETTE
           ' statements
           ' 1 = cyan, 2 = magenta, 3 = hi.
           ' intens. white
```

With the EGA, the default color settings for the *palette* parameter are equivalent to the following:

```
COLOR , 0  ' Same as the next three PALETTE
           ' statements
PALETTE 1, 2 ' Attribute 1 = color 3 (green)
PALETTE 2, 4 ' Attribute 2 = color 5 (red)
PALETTE 3, 6 ' Attribute 3 = color 6 (brown)
```

```
COLOR , 1  ' Same as the next three PALETTE
           ' statements
PALETTE 1, 3 ' Attribute 1 = color 3 (cyan)
PALETTE 2, 5 ' Attribute 2 = color 5 (magenta)
PALETTE 3, 7 ' Attribute 3 = color 15 (white)
```

Note that a **COLOR** statement will override previous **PALETTE** statements.

**SCREEN 2** No effect. An "Illegal function call" error message occurs if **COLOR** is used in this mode.

## SCREEN 7- SCREEN 10

In these modes, no *border* color can be specified. The graphics background is given by the *background* color number, which must be in the valid range of color numbers appropriate to the screen mode. See the **SCREEN** statement reference pages for more details. The *foreground* color argument is the default line drawing color.

Arguments outside valid numeric ranges result in "**Illegal function call**" errors.

The foreground color may be the same as the background color, making displayed characters invisible. The default background color is black, or color number 0, for all display hardware configurations and all screen modes.

With the Enhanced Graphics Adapter (EGA) installed, the **PALETTE** statement gives you flexibility in assigning different display colors to the actual color-number ranges for the *foreground*, *background*, and *border* colors discussed above. See the **PALETTE** statement reference pages for more details.

For more information, see **CIRCLE**, **DRAW**, **LINE**, **PALETTE**, **PAINT**, **PRESET**, **PSET**, **SCREEN**

### Examples:

The following series of examples show **COLOR** statements and their effects in the various screen modes:

**SCREEN 0**

**COLOR 1, 2, 3 ' foreground=1, background=2, border=3**

**SCREEN 1**

**COLOR 1, 0 ' foreground=1, even palette number**

**COLOR 2, 1 ' foreground=2, odd palette number**

**SCREEN 7**

**COLOR 3, 5 ' foreground=3, background=5**

**SCREEN 8**

**COLOR 6, 7 ' foreground=6, background=7**

**SCREEN 9**

**COLOR 1, 2 ' foreground=1, background=2**

# COM(*n*) Statement

## Purpose:

To enable or disable trapping of communications activity to the specified communications adapter.

## Syntax:

COM(*n*) ON  
COM(*n*) OFF  
COM(*n*) STOP

## Comments:

*n* is the number of the communications adapter 1 or 2.

Execute a COM(*n*) ON statement before ON COM(*n*) statement to allow trapping. After COM(*n*) ON, if a nonzero number is specified in the ON COM(*n*) statement, BASIC checks every new statement to see if any characters have come in the communication adapter.

With COM(*n*) OFF, no trapping takes place, and all communications activity will be lost.

With COM(*n*) STOP, no trapping takes place. However, any communication that takes place will be remembered so that immediate trapping will occur when COM(*n*) ON is executed.

# COMMON Statement

## Purpose:

To pass variables to a chained program.

## Syntax:

**COMMON** *variables*

## Comments:

*variables* are one or more variables, separated by commas, that you want to pass to the chained program.

The **COMMON** statement is used in conjunction with the CHAIN statement.

**COMMON** statements may appear anywhere in a program, although it is recommended that they appear at the beginning.

Any number of **COMMON** statements may appear in a program, but the same variable cannot appear in more than one **COMMON** statement. To pass all variables using the **CHAIN** statement, use the all option, and omit the **COMMON** statement.

Place parentheses after the variable name to indicate array variables.

## Examples:

```
100 COMMON A, B, C, D(), GS  
110 CHAIN "A: PROG3"
```

This example chains to program PROG3 on disk drive A:, and passes the array D along with the variables A, B, C, and string G\$.



# CONT Command

## Purpose:

To continue program execution after a break.

## Syntax:

CONT

## Comments:

Resumes program execution after CTRL-BREAK, **STOP**, or **END** halts a program. Execution continues at the point where the break happened. If the break took place during an **INPUT** statement, execution continues after reprinting the prompt.

**CONT** is useful in debugging, in that it lets you set break points with the **STOP** statement, modify variables using direct statements, continue program execution, or use **GOTO** to resume execution at a particular line number.

If a program line is modified, **CONT** will be invalid.

# COS Function

## Purpose:

To return the cosine of the range of **x**.

## Syntax:

**COS(x)**

## Comments:

**x** must be the radians. **COS** is the trigonometric cosine function. To convert from degrees to radians, multiply by  $\pi/180$ .

**COS(x)** is calculated in single precision unless the **/d** switch is used when GW-BASIC is executed.

## Example 1:

```
10 X=2*COS(.4)
20 PRINT X
RUN
1.842122
Ok
```

## Example 2:

```
10 PI=3.141593
20 PRINT COS(PI)
30 DEGREES=180
40 RADIANS=DEGREES*PI/180
50 PRINT COS(RADIANS)
RUN
-1
-1
OK
```

# CSNG Function

## Purpose:

To convert **x** to a single-precision number.

## Syntax:

**CSNG(x)**

## Comments:

**x** must be a numeric expression (see the **CINT** and **CDBL** functions).

## Examples:

```
10 A#=975.3421222#  
20 PRINT A#; CSNG(A#)  
RUN  
975.3421222 975.3421  
Ok
```

# CSRLIN Variable

## Purpose:

To return the current line (row) position of the cursor.

## Syntax:

`y=CSRLIN`

## Comments:

`y` is a numeric variable receiving the value returned. The value returned is within the range of 1 to 25.

The **CSRLIN** Variable returns the vertical coordinate of the cursor on the active page (see the **SCREEN** statement).

`x=POS(0)` returns the column location of the cursor. The value returned is within the range of 1 to 40, or 1 to 80, depending on the current screen width (see the **POS** function).

## Examples:

```
10 Y=CSRLIN
20 X=POS(0)
30 LOCATE 24, 1
40 PRINT "HELLO"
50 LOCATE Y, X
RUN
HELLO
Ok
```

The **CSRLIN** Variable in line 10 records the current line.

The **POS** function in line 20 records the current column.

In line 40, the **PRINT** statement displays the comment "**HELLO**" on the 24<sup>th</sup> line of the screen.

The **LOCATE** statement in line 50 restores the position of the cursor to the original line and column.

# CVI, CVS, CVD Functions

## Purpose:

To convert string values to numeric values.

## Syntax:

*CVI (2-byte string)*

*CVS (4-byte string)*

*CVD (8-byte string)*

## Comments:

Numeric values read in from a random-access disk file must be converted from strings back into numbers if they are to be arithmetically manipulated.

**CVI** converts a 2-byte string to an integer. **MKI \$** is its complement.

**CVS** converts a 4-byte string to a single-precision number. **MKSS** is its complement.

**CVD** converts an 8-byte string to a double-precision number. **MKDS** is its complement.

(See **MKI \$**, **MKSS**, and **MKDS**).

## Examples:

```
. . .  
70 FIELD #1, 4 AS N$, 12 AS B$. . .  
80 GET #1  
90 Y=CVS(N$)
```

## CVI, CVS, CVD Functions

Line 80 reads a field from file #1 (the field read is defined in line 70), and converts the first four bytes (N\$) into a single-precision number assigned to the variable Y.

Since a single-precision number can contain as many as seven ASCII characters (seven bytes), writing a file using **MKSS** conversion, and reading with the **CVS** conversion, as many as three bytes per number recorded are saved on the storage medium. Even more may be saved if double-precision numbers are required. **MKDS** and **CVD** conversions would be used in this case.

# DATA Statement

Purpose:

To store the numeric and string constants that are accessed by the program **READ** statement(s).

**Syntax:**

**DATA** *constants*

**Comments:**

**constants** are numeric constants in any format (fixed point, floating-point, or integer), separated by commas. No 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.

**DATA** statements are not executable and may be placed anywhere in the program. A **DATA** statement can contain as many constants that will fit on a line (separated by commas), and any number of **DATA** statements may be used in a program.

**READ** statements access the **DATA** statements in order (by line number). 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. The variable type (numeric or string) given in the **READ** statement must agree with the corresponding constant in the **DATA** statement, or a "Type Mismatch" error occurs.

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

For further information and examples, see the **RESTORE** statement and the **READ** statement.

### Example 1:

```
. . .  
80 FOR I=1 TO 10  
90 READ A(I)  
100 NEXT I  
110 DATA 3. 08, 5. 19, 3. 12, 3. 98, 4. 24  
120 DATA 5. 08, 5. 55, 4. 00, 3. 16, 3. 37  
. . .
```

This program segment reads the values from the **DATA** statements into array A. After execution, the value of A(1) is 3.08, and so on. The **DATA** statements (lines 110-120) may be placed anywhere in the program; they may even be placed ahead of the **READ** statement.

### Example 2:

```
5 PRINT  
10 PRINT "CITY", "STATE", "ZIP"  
20 READ C$, S$, Z  
30 DATA "DENVER, ", "COLORADO", 80211  
40 PRINT C$, S$, Z  
RUN
```

```
CITY STATE ZIP  
DENVER, COLORADO 80211  
Ok
```

This program reads string and numeric data from the **DATA** statement in line 30.

# DATE\$ Statement and Variable

## Purpose:

To set or retrieve the current date.

## Syntax:

As a statement:

**DATE\$=v\$**

As a variable:

**v\$=DATE\$**

## Comments:

**v\$** is a valid string literal or variable.

**v\$** can be any of the following formats when assigning the date:

**mm-dd-yy**  
**mm/dd/yy**  
**mm-dd-yyyy**  
**mm/dd/yyyy**

If **v\$** is not a valid string, a "**Type Mismatch**" error results. Previous values are retained.

If any of the values are out of range or missing, an "**Illegal Function Call**" error is issued. Any previous date is retained.

The current date (as assigned when the operating system was initialized) is fetched and assigned to the string variable if **DATE\$** is the expression in a **LET** or **PRINT** statement.

The current date is stored if **DATE\$** is the target of a string assignment. With **v\$=DATE\$**, **DATE\$** returns a 10-character string in the form **mm-dd-yyyy**. **mm** is the month (01 to 12), **dd** is the day (01 to 31), and **yyyy** is the year (1980 to 2099).

## Examples:

```
v$=DATE$  
Ok  
PRINT v$  
01-01-1985  
Ok
```



# DEF FN Statement

## Purpose:

To define and name a function written by the user.

## Syntax:

**DEF FN***name*[*arguments*] *expression*

## Comments:

*name* must be a legal variable name. This name, preceded by **FN**, becomes the name of the function.

*arguments* consists of those variable names in the function definition that are to be replaced when the function is called. The items in the list are separated by commas.

*expression* is an expression that performs the operation of the function. It is limited to one statement.

In the **DEF FN** statement, arguments serve only to define the function; they do not affect program variables that have the same name. A variable name used in a function definition may or may not appear in the argument. If it does, the value of the parameter is supplied when the function is called. Otherwise, the current value of the variable is used.

The variables in the argument represent, on a one-to-one basis, the argument variables or values that are to be given in the function call.

User-defined functions may be numeric or string. If a type is specified in the function name, 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.

A user-defined function may be defined more than once in a program by repeating the **DEF FN** statement.

A **DEF FN** statement must be executed before the function it defines may be called. If a function is called before it has been defined, an "**Undefined User Function**" error occurs.

**DEF FN** is illegal in the direct mode.

Recursive functions are not supported in the **DEF FN** statement.

## Examples:

```
. . .  
400 R=1: S=2  
410 DEF FNAB(X, Y)=X^3/Y^2  
420 T=FNAB(R, S)  
. . .
```

Line 410 defines the user-defined function **FNAB**. The function is called in line 420. When executed, the variable T will contain the value R 3 divided by S 2, or .25.

# DEFINT/SNG/DBL/STR Statements

## Purpose:

To declare variable types as integer, single-precision, double-precision, or string.

## Syntax:

*DEFtype letters*

## Comments:

*type* is **INT** (integer), **SNG** (single-precision number), **DBL** (double-precision number), or **STR** (string of 0-255 characters).

*letters* are letters (separated by commas) or range of letters of the alphabet.

A **DEFtype** statement declares that variable names beginning with the letter(s) specify that type of variable. However, a type declaration character (**%**, **!**, **#**, **\$**) always takes precedence over a **DEFtype** statement in the typing of a variable.

If no type declaration statements are encountered, BASIC assumes all variables are single-precision. Single-precision is the default value.

## Examples:

```
10 DEFDBL L-P
```

All variables beginning with the letters L, M, N, O, and P will be double-precision variables.

```
10 DEFSTR A
20 A="120#"
```

All variables beginning with the letter A will be string variables. The \$ declaration is unnecessary in this example.

```
10 DEFINT I-N, W-Z
20 W$="120#"
```

All variables beginning with the letters I, J, K, L, M, N, W, X, Y, Z will be integer variables. W\$ in Line 20 establishes a string variable beginning with the letter W. However, the variable W will remain an integer elsewhere in the program.

# DEF SEG Statement

## Purpose:

To assign the current segment address to be referenced by a subsequent **BLOAD**, **BSAVE**, **CALL**, **PEEK**, **POKE**, or **USR**.

## Syntax:

**DEF SEG** [=*address*]

## Comments:

*address* is a numeric expression within the range of 0 to 65535.

The address specified is saved for use as the segment required by **BLOAD**, **BSAVE**, **PEEK**, **POKE**, and **CALL** statements.

Entry of any value outside the address range (0-65535) results in an "Illegal Function Call" error, and the previous value is retained.

If the address option is omitted, the segment to be used is set to GW-BASIC's data segment (DS). This is the initial default value. If you specify the address option, base it on a 16-byte boundary. Segment addresses are shifted 4 bits to the left; so to get the segment address, divide the memory location by 16.

For **BLOAD**, **BSAVE**, **PEEK**, **POKE**, or **CALL** statements, the value is shifted left four bits (this is done by the microprocessor, not by GW-BASIC) to form the code segment address for the subsequent call instruction (see the **BLOAD**, **BSAVE**, **CALL**, **PEEK**, and **POKE** statements).

GW-BASIC does not perform additional checking to assure that the resultant segment address is valid.

## Examples:

**10 DEF SEG=&HB800**

Sets segment to screen buffer.

**20 DEF SEG**

Restores segment to BASIC DS.

## Note

**DEF** and **SEG** must be separated by a space. Otherwise, GW-BASIC will interpret the statement **DEFSEG=100** to mean, "assign the value 100 to the variable DEFSEG."

# DEF USR Statement

## Purpose:

To specify the starting address of an assembly language subroutine to be called from memory by the **USR** function.

## Syntax:

**DEF USR**[*n*]=*integer*

## Comments:

*n* may be any digit from 0 to 9. The digit corresponds to the **USR** routine address being specified. If *n* is omitted, **DEF USR0** is assumed.

*integer* is the offset address of the **USR** routine. If more than 10 **USR** routines are required, **DEF USR**[*n*] may appear in the program as many times as necessary to redefine the **USR**[*n*] starting address.

Add the current segment value to the integer to get the starting address of the user routine.

When an Assembly Language Subroutine is called, the GW-BASIC program execution is paused, and control is transferred to the Assembly Language program. When that program is executed, control is returned to the GW-BASIC program at the point of interruption.

## Examples:

```
190 DEF SEG=0
200 DEF USR0=24000
210 X=USR0(Y^2/2.82)
. . .
```

Lines 190 and 200 set the absolute address.

Line 210 calls the **USR** routine located at that address, and passes the integer value of the expression contained within the parentheses to the user program (see **USR**).

## Note

This statement is given here primarily to provide compatibility with other GW-BASIC implementations. The more versatile **CALL** statement should be used if this downward compatibility is unimportant.

# DELETE Command

## Purpose:

To delete program lines or line ranges.

## Syntax:

```
DELETE [line number1][-line number2]  
DELETE line number1-
```

## Comments:

*line number1* is the first line to be deleted.

*line number2* is the last line to be deleted.

GW-BASIC always returns to command level after a **DELETE** command is executed. Unless at least one line number is given, an "Illegal Function Call" error occurs.

The period (.) may be used to substitute for either line number to indicate the current line.

## Examples:

```
DELETE 40
```

Deletes line 40.

```
DELETE 40- 100
```

Deletes lines 40 through 100, inclusively.

```
DELETE - 40
```

Deletes all lines up to and including line 40.

```
DELETE 40-
```

Deletes all lines from line 40 to the end of the program.

# DIM Statement

## Purpose:

To specify the maximum values for array variable subscripts and allocate storage accordingly.

## Syntax:

**DIM** *variable(subscripts)* [, *variable(subscripts)*] . . .

## Comments:

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 greater than the maximum specified is used, a "**Subscript out of range**" error occurs.

The maximum number of dimensions for an array is 255.

The minimum value for a subscript is always 0, unless otherwise specified with the **OPTION BASE** statement.

An array, once dimensioned, cannot be redimensioned within the program without first executing a **CLEAR** or **ERASE** statement.

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

## Examples:

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

This example reads 21 **DATA** statements elsewhere in the program and assigns their values to A(0) through A(20), sequentially and inclusively. If the A array is single precision (default accuracy) then line 10 will allocate 84 bytes of memory to this array (4 bytes times 21 elements).

# DRAW Statement

## Purpose:

To draw a figure.

## Syntax:

*DRAW string expression*

## Comments:

The **DRAW** statement combines most of the capabilities of the other graphics statements into an object definition language called Graphics Macro Language (GML). A GML command is a single character within a string, optionally followed by one or more arguments.

The **DRAW** statement is valid only in graphics mode.

Movement Commands: Each of the following movement commands begins movement from the current graphics position. This is usually the coordinate of the last graphics point plotted with another GML command, **LINE**, or **PSET**. The current position defaults to the center of the screen (160,100 in medium resolution; 320,100 in high resolution) when a program is run. Movement commands move for a distance of scale factor \**n*, where the default for *n* is 1; thus, they move one point if *n* is omitted and the default scale factor is used.

| Command   | Moves                     |
|-----------|---------------------------|
| <b>Un</b> | up                        |
| <b>Dn</b> | down                      |
| <b>Ln</b> | left                      |
| <b>Rn</b> | right                     |
| <b>En</b> | diagonally up and right   |
| <b>Fn</b> | diagonally down and right |
| <b>Gn</b> | diagonally down and left  |
| <b>Hn</b> | diagonally up and left    |



This command moves as specified by the following argument:

**Mx, y** Move absolute or relative. If **x** is preceded by a **+** or **-**, **x** and **y** are added to the current graphics position, and connected to the current position by a line. Otherwise, a line is drawn to point **x,y** from the current position.

The following prefix commands may precede any of the above movement commands:

**B** Move, but plot no points.

**N** Move, but return to original position when done.

The following commands are also available:

**An** Set angle **n**. **n** may range from 0 to 3, where 0 is 0°, 1 is 90°, 2 is 180°, and 3 is 270°. Figures rotated 90° or 270° are scaled so that they will appear the same size as with 0° or 180° on a monitor screen with the standard aspect ratio of 4:3.

**TAn** Turn angle **n**. **n** can be any value from negative 360 to positive 360. If the value specified by **n** is positive, it turns the angle counter-clockwise. If the value specified by **n** is negative, it turns clockwise.

**Cn** Set color **n**. See the **COLOR**, **PALETTE**, and **SCREEN** statements for discussions of valid colors, numbers and attributes.

**Sn** Set scale factor. **n** may range from 1 to 255. **n** is divided by 4 to derive the scale factor. The scale factor is multiplied by the distances given with **U**, **D**, **L**, **R**, **E**, **F**, **G**, **H**, or relative **M** commands to get the actual distance traveled. The default for **S** is 4.

**xstring;**  
**variable** Execute substring. This command executes a second substring from a string, much like **GOSUB**. One string executes another, which executes a third, and so on.

**string** is a variable assigned to a string of movement commands.

## ***Ppaint, boundary***

Specifies the colors for a graphics figure and creates a filled-in figure.

paint specifies what color you want the figure filled in with.

boundary specifies the border color (outline).

See the **COLOR**, **PALETTE**, and **SCREEN** statements for discussions of valid colors, numbers and attributes.

You must specify values for both ***paint*** and ***boundary*** when used.

This command (***Ppaint, boundary***) does not paint color tiling.

### **Numeric Arguments:**

Numeric arguments can be constants like "**123**" or "**=variable**;", where variable is the name of a variable.

When you use the second syntax, "**=variable**;", the semicolon must be used. Otherwise, the semicolon is optional between commands.

You can also specify variables using **VARPTRS(variable)**.

### Example 1:

To draw a box in medium resolution:

```
10 SCREEN 1
20 A=20
30 DRAW "U=A; R=A; D=A; L=A; "
RUN
```

### Example 2:

The aspect ratio to draw a square on a standard screen is 4:3, as shown below:

To draw a 96 pixel-wide square on a 640 x 200 pixel screen (**SCREEN 2**), do the following calculations:

```
Horizontal value = 96
Vertical value = 96*(200/640)*(4/3)
```

or

```
Vertical value = 40
Horizontal value = 40*(640/200)*(3/4)
```

The horizontal values equals 4/3 of the vertical values.

### Example 3:

To draw a triangle in medium resolution:

```
10 CLS
20 SCREEN 1
30 PSET (60, 125)
40 DRAW "E100; F100; L199"
RUN
```

# EDIT Command

## Purpose:

To display a specified line, and to position the cursor under the first digit of the line number, so that the line may be edited.

## Syntax:

```
EDIT line number  
EDIT .
```

## Comments:

*line number* is the number of a line existing in the program.

A period (.) refers to the current line. The following command enters **EDIT** at the current line:

```
EDIT .
```

When a line is entered, it becomes the current line.

The current line is always the last line referenced by an **EDIT** statement, **LIST** command, or error message.

If *line number* refers to a line which does not exist in the program, an "Undefined Line Number" error occurs.

## Examples:

```
EDIT 150
```

Displays program line number 150 for editing.

# END Statement

## Purpose:

To terminate program execution, close all files, and return to command level.

## Syntax:

**END**

## Comments:

**END** statements may be placed anywhere in the program to terminate execution.

Unlike the **STOP** statement, **END** does not cause a "**Break in line xxxx**" message to be printed.

An **END** statement at the end of a program is optional. GW-BASIC always returns to command level after an **END** is executed.

END closes all files.

## Examples:

**520 IF K>1000 THEN END ELSE GOTO 20**

Ends the program and returns to command level whenever the value of K exceeds 1000.

# ENVIRON Statement

## Purpose:

To allow the user to modify parameters in GW-BASIC's environment string table. This may be to change the path parameter for a child process, (see [ENVIRON\\$](#), [SHELL](#), and the MS-DOS utilities PATH command), or to pass parameters to a child by inventing a new environment parameter.

## Syntax:

`ENVIRON string`

## Comments:

*string* is a valid string expression containing the new environment string parameter.

*string* must be of the following form

*parmi d=text*

where *parmi d* is the name of the parameter such as PATH.

*parmi d* must be separated from text by an equal sign or a blank. **ENVIRON** takes everything to the left of the first blank or equal sign as the *parmi d*; everything following is taken as text.

*text* is the new parameter text. If *text* is a null string, or consists only of a single semicolon, then the parameter (including *parmi d=*) is removed from the environment string table, and the table is compressed. *text* must not contain any embedded blanks.

If *parmi d* does not exist, then *string* is added at the end of the environment string table.

If *parmi d* does exist, it is deleted, the environment string table is compressed, and the new string is added at the end.

## Examples:

Assuming the environment string table is empty, the following statement will create a default path to the root directory on Disk A:

```
ENVIRON "PATH=A: \"
```

If your work subdirectory were john, you would be able to get DEBUG from the root.

A new parameter may be added:

```
ENVIRON "COMSPEC=A: \COMMAND.COM"
```

The environment string table now contains

```
PATH=A: \; COMSPEC=A: \COMMAND.COM
```

The path may be changed to a new value:

```
ENVIRON "PATH=A: \SALES; A: \ACCOUNTING"
```

The path parameter may be appended by using the **ENVIRON\$** function with the **ENVIRON** statement:

```
ENVIRON "PATH="+ENVIRON$("PATH")+"; B: \SAMPLES"
```

Finally, delete the parameter COMSPEC:

```
ENVIRON "COMSPEC=; "
```

The environment string table now contains

```
PATH=A: \SALES; A: \ACCOUNTING; B: \SAMPLES
```

# ENVIRON\$ Function

## Purpose:

To allow the user to retrieve the specified environment string from the environment table.

## Syntax:

```
v$=ENVIRON$(parmi d)  
v$=ENVIRON$(nthparm)
```

## Comments:

*parmi d* is a valid string expression containing the parameter to search for.

*nthparm* is an integer expression in the range of 1 to 255.

If a string argument is used, **ENVIRON\$** returns a string containing the text following *parmi d*= from the environment string table.

If *parmi d* is not found, then a null string is returned.

If a numeric argument is used, **ENVIRON\$** returns a string containing the *n<sup>th</sup>* parameter from the environment string table.

If there is no *n<sup>th</sup>* parameter, then a null string is returned.

The **ENVIRON\$** function distinguishes between upper- and lowercase.

## Examples:

The following lines:

```
ENVIRON "PATH=A: \SALES; A: \ACCOUNTING; B: \MKT: " ' Create entry  
PRINT ENVIRON$("PATH") ' Print entry
```

will print the following string:

```
A: \SALES; A: \ACCOUNTING; B: \MKT
```

The following line will print the first string in the environment:

```
PRINT ENVIRON$(1)
```



The following program saves the environment string table in an array so that it can be modified for a child process. After the child process completes, the environment is restored.

```
10  DIM ENVTBL$(10) "  
20  NPARMS= 1  
30  WHILE LEN(ENVIRON$(NPARMS)) >0  
40  ENVTBL$(NPARMS)= ENVIRON$(NPARMS)  
50  NPARMS= NPARMS + 1  
60  WEND  
70  NPARMS= NPARMS- 1  
72  WHILE LEN(ENVIRON$(1))>0  
73  AS=MID$(ENVIRON$(1), 1, INSTR (ENVIRON$(1), "="))  
74  ENVIRON AS+"; "  
75  WEND  
90  ENVIRON "MYCHILDPARM1=SORT BY NAME"  
100 ENVIRON "MYCHILDPARM2=LIST BY NAME"  
1000 SHELL "MYCHILD"" RUNS "MYCHILD. EXE"  
1002 WHILE LEN(ENVIRON$(1))>0  
1003 AS=MID$(ENVIRON$(1), 1, INSTR(ENVIRON$(1), "="))  
1004 ENVIRON AS+"; "  
1005 WEND  
1010 FOR I=1 TO NPARMS  
1020 ENVIRON ENVTBL$(I)  
1030 NEXT I
```

The **DIM** statement in line 10 assumes no more than 10 parameters will be accessed.

In line 20, the initial number of parameters is established as 1.

In lines 30 through 70, a series of statements are used to adjust and correct the parameter numbers.

Line 71 deletes the present environment.

Lines 72 through 80 create a new environment. Line 74 deletes the string.

Lines 80 through 100 store the new environment.

Lines 1000 through 1030 repeat the procedure by deleting the present environment and restore the parameters established in the first part of the program.

# EOF Function

## Purpose:

To return -1 (true) when the end of a sequential or a communications file has been reached, or to return 0 if end of file (EOF) has not been found.

## Syntax:

**v=EOF(*file number*)**

## Comments:

If a **GET** is done past the end of the file, **EOF** returns -1. This may be used to find the size of a file using a binary search or other algorithm. With communications files, a -1 indicates that the buffer is empty.

Use **EOF** to test for end of file while inputting to avoid "Input Past End" errors.

## Examples:

```
10 OPEN "I", 1, "DATA"
20 C=0
30 IF EOF(1) THEN 100
40 INPUT#1, M(C)
50 C=C+1: GOTO 30
100 END
RUN
```

The file named DATA is read into the M array until the end of the file is reached, then the program branches to line 100.

# ERASE Statement

## Purpose:

To eliminate arrays from a program.

## Syntax:

ERASE *list of array variables*

## Comments:

Arrays may be redimensioned after they are erased, or the memory space previously allocated to the array may be used for other purposes.

If an attempt is made to redimension an array without first erasing it, an error occurs.

## Examples:

```
200 DIM B (250)
```

```
450 ERASE A, B
```

```
460 DIM B(3, 4)
```

Arrays A and B are eliminated from the program. The B array is redimensioned to a 3-column by 4-row array (12 elements), all of which are set to a zero value.

# ERDEV and ERDEV\$ Variables

## Purpose:

To return the actual value (**ERDEV**) of a device error, and the name of the device (**ERDEV\$**) causing the error.

## Syntax:

**ERDEV**  
**ERDEV\$**

## Comments:

**ERDEV** will contain the error code from interrupt 24H in the lower 8 bits. Bits 8 to 15 from the attribute word in the Device Header Block are mapped directly into the upper 8 bits.

**ERDEV\$** will contain the 8-byte character device name if the error was on a character device. It will contain the 2 byte block device name (A:, B:, etc.) if the device was not a character device.

## Examples:

Installed device driver lpt2: caused a "**Printer out of paper**" error via INT 24H.

**ERDEV** contains the error number 9 in the lower 8 bits, while the upper 8 bits contain the upper byte of the Device Header word attributes.

**ERDEV\$** contains "**LPT2:** ".

# ERR and ERL Variables

## Purpose:

To return the error code (**ERR**) and line number (**ERL**) associated with an error.

## Syntax:

**v=ERR**

**v=ERL**

## Comments:

The variable **ERR** contains the error code for the last occurrence of an error. All the error codes and their definitions are listed in Appendix A of the GW-BASIC User's Guide. 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**, or **ON ERROR. . . GOTO**, or **GOSUB** statements to direct program flow in error trapping.

If the statement that caused the error was a direct mode statement, **ERL** will contain 65535. To test if an error occurred in a direct mode statement, use a line of the following form:

**IF 65535=ERL THEN . . .**

Otherwise, use the following:

```
10 IF ERR=error code THEN . . GOSUB 4000
20 IF ERL=line number THEN . . GOSUB 4010
```

**ERR** and **ERL** Variables

---

## Note

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.

# ERROR Statement

## Purpose:

To simulate the occurrence of an error, or to allow the user to define error codes.

## Syntax:

**ERROR** *integer expression*

## Comments:

The value of *integer expression* must be greater than 0 and less than 255.

If the value of *integer expression* equals an error code already in use by GW-BASIC, the **ERROR** statement simulates the occurrence of that error, and the corresponding error message is printed.

A user-defined error code must use a value greater than any used by the GW-BASIC error codes. There are 76 GW-BASIC error codes at present. It is preferable to use a code number high enough to remain valid when more error codes are added to GW-BASIC.

User-defined error codes may be used in an error-trapping routine.

If an **ERROR** statement specifies a code for which no error message has been defined, GW-BASIC responds with the message "**Unprintable Error**".

Execution of an **ERROR** statement for which there is no error-trapping routine causes an error message to be printed and execution to halt.

For a complete list of the error codes and messages already defined in GW-BASIC, refer to Appendix A in the GW-BASIC User's Guide.

## Examples:

The following examples simulate error 15 (the code for "String too long"):

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

Or, in direct mode:

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

The following example includes a user-defined error code message.

```
110 ON ERROR GOTO 400
120 INPUT "WHAT IS YOUR BET"; B
130 IF B>5000 THEN ERROR 210

400 IF ERR=210 THEN PRINT "HOUSE LIMIT IS $5000"
410 IF ERL=130 THEN RESUME 120
```

# EXP Function

## Purpose:

To return e (the base of natural logarithms) to the power of **x**.

## Syntax:

**EXP(x)**

## Comments:

**x** must be less than 88.02969.

If **EXP** overflows, the "**Overflow**" error message appears; machine infinity with the appropriate sign is supplied as the result, and execution continues.

**EXP(x)** is calculated in single precision, unless the **/d** switch is used when GW-BASIC is executed.

## Examples:

```
10 X = 5
20 PRINT EXP(X-1)
RUN
54.59815
Ok
```

Prints the value of e to the 4th power.



# EXTERR Function

## Purpose:

To return extended error information.

## Syntax:

**EXTERR**(*n*)

## Comments:

**EXTERR** returns "extended" error information provided by versions of DOS 3.0 and greater. For versions of DOS earlier than 3.0, **EXTERR** always returns zero. The single integer argument must be in the range 0-3 as follows:

| Value of <i>n</i> | Return Value                    |
|-------------------|---------------------------------|
| 0                 | Extended error code             |
| 1                 | Extended error class            |
| 2                 | Extended error suggested action |
| 3                 | Extended error locus            |

The values returned are not defined by GW-BASIC, but by DOS. Refer to the MS-DOS Programmer's Reference (version 3.0 or later) for a description of the values returned by the DOS extended error function.

The extended error code is actually retrieved and saved by GW-BASIC each time appropriate DOS functions are performed. Thus when an **EXTERR** function call is made, these saved values are returned.

# FIELD Statement

## Purpose:

To allocate space for variables in a random file buffer.

## Syntax:

**FIELD** [#] *filenum*, *width* **AS** *stringvar* [, *width* **AS** *stringvar*]...

## Comments:

*filenum* is the number under which the file was opened.

*width* is the number of characters to be allocated to the string variable.

*string variable* is a string variable which will be used for random file access.

A **FIELD** statement must have been executed before you can

- o get data out of a random buffer after a **GET** statement
- o enter data before a **PUT** statement

For example, the following line 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 1, 20 AS N\$, 10 AS ID\$, 40 AS ADD\$**

**FIELD** only allocates space, it does not place any data in the random file buffer.

The total number of bytes allocated in a **FIELD** statement must not exceed the record length specified when the file was opened. Otherwise, a "**Field overflow**" error occurs (the default record length is 128).

Any number of **FIELD** statements may be executed for the same file, and all **FIELD** statements executed are in effect at the same time.

## Note

Do not use a fielded variable name in an **INPUT** or **LET** statement. Once a variable name is fielded, it points to the correct place 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 (see **LSET/RSET** and **GET** statements).

# FILES Command

## Purpose:

To print the names of the files residing on the specified drive.

## Syntax:

**FILES** [*pathname*]

## Comments:

If *pathname* is omitted, the command lists all files in the current directory of the selected drive. *pathname* may contain question marks (?) to match any character in the filename or extension. An asterisk (\*) as the first character of the filename or extension will match any file or any extension.

This syntax also displays the name of the directory and the number of bytes in the file. When a tree-structured directory is used, two special symbols also appear.

Subdirectories are denoted by <DIR> following the directory name.

## Examples:

```
FILES
FILES "*.BAS"
FILES "B: *. *"
FILES "TEST?.BAS"
```

**FILES** now allows pathnames. The directory for the specified path is displayed. If an explicit path is not given, the current directory is assumed.

```
FILES "ACCTS\"
```

Lists all files in the directory named accts that are on the diskette in Drive B: and have the extension of .pay.

```
FILES "B: ACCTS\*.PAY"
```

Lists all files in the directory named accts that are on the diskette in Drive B: and have the extension of .PAY.

# FIX Function

## Purpose:

To truncate  $x$  to a whole number.

## Syntax:

**FIX( $x$ )**

## Comments:

**FIX** does not round off numbers, it simply eliminates the decimal point and all characters to the right of the decimal point.

**FIX( $x$ )** is equivalent to **SGN( $x$ ) \* INT(ABS( $x$ ))** . The major difference between **FIX** and **INT** is that **FIX** does not return the next lower number for negative  $x$ .

**FIX** is useful in modulus arithmetic.

## Examples:

```
PRINT FIX(58.75)
```

```
58
```

```
Ok
```

```
PRINT FIX(-58.75)
```

```
-58
```

```
Ok
```

# FOR and NEXT Statements

## Purpose:

To execute a series of instructions a specified number of times in a loop.

## Syntax:

```
FOR variable=x TO y [STEP z]  
NEXT [ variable] [, variable . . . ]
```

## Comments:

*variable* is used as a counter.

*x*, *y*, and *z* are numeric expressions.

**STEP *z*** specifies the counter increment for each loop.

The first numeric expression (*x*) is the initial value of the counter. The second numeric expression (*y*) is the final value of the counter.

Program lines following the **FOR** statement are executed until the **NEXT** statement is encountered. Then, the counter is incremented by the amount specified by **STEP**.

If **STEP** is not specified, the increment is assumed to be 1.

A check is performed to see if the value of the counter is now greater than the final value (*y*). If it is not greater, GW-BASIC branches back to the statement after the FOR statement, and the process is repeated. If it is greater, execution continues with the statement following the **NEXT** statement. This is a **FOR-NEXT** loop.

The body of the loop is skipped if the initial value of the loop times the sign of the step exceeds the final value times the sign of the step.

If **STEP** is negative, the final value of the counter is set to be less than the initial value. The counter is decremented each time through the loop, and the loop is executed until the counter is less than the final value.

## Nested Loops:

**FOR- NEXT** loops may be nested; that is, a **FOR- NEXT** loop may be placed within the context of another **FOR- NEXT** loop. When loops are nested, each loop must have a unique variable name as its counter.

The **NEXT** statement for the inside loop must appear before that for the outside loop.

If nested loops have the same end point, a single **NEXT** statement may be used for all of them.

The *variable(s)* in the **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.

## Examples:

The following example prints integer values of the variable I% from 1 to 10 in steps of 2. For fastest execution, I is declared as an integer by the % sign.

```
10 K=10
20 FOR I%=1 TO K STEP 2
30 PRINT I%

60 NEXT
RUN
1
3
5
7
9
Ok
```

In the following example, the loop does not execute because the initial value of the loop exceeds the final value. Nothing is printed by this example.

```
10 R=0
20 FOR S=1 TO R
30 PRINT S
40 NEXT S
```

In the next example, the loop executes 10 times. The final value for the loop variable is always set before the initial value is set.

```

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

```

## FRE Function

### Purpose:

To return the number of available bytes in allocated string memory.

### Syntax:

```

FRE(x$)
FRE(x)

```

### Comments:

Arguments (*x\$*) and (*x*) are dummy arguments.

Before **FRE (*x\$*)** returns the amount of space available in allocated string memory, GW-BASIC initiates a "garbage collection" activity. Data in string memory space is collected and reorganized, and unused portions of fragmented strings are discarded to make room for new input.

If **FRE** is not used, GW-BASIC initiates an automatic garbage collection activity when all string memory space is used up. GW-BASIC will not initiate garbage collection until all free memory has been used. Garbage collection may take 1 to 1.5 minutes.

**FRE( " ")** or any string forces a garbage collection before returning the number of free bytes. Therefore, using **FRE( " ")** periodically will result in shorter delays for each garbage collection.

It should be noted that the CTRL-BREAK function cannot be used during this housecleaning process.

### Examples:

```

PRINT FRE(0)
14542
Ok

```

Your computer may return a different value.

# GET Statement (Files)

## Purpose:

To read a record from a random disk file into a random buffer.

## Syntax:

*GET [#] file number[, record number]*

## Comments:

*file number* is the number under which the file was opened.

*record number* is the number of the record, within the range of 1 to 16,777,215.

If *record number* is omitted, the next record (after the last *GET*) is read into the buffer.

After a *GET* statement, *INPUT#* and *LINE INPUT#* may be used to read characters from the random file buffer.

*GET* may also be used for communications files. record number is the number of bytes to be read from the communications buffer. *record number* cannot exceed the buffer length set in the *OPEN COM(n)* statement.

## Examples:

The following example opens the vendor file for random access, defines the fields, reads a record, then displays it:

```
10 OPEN "R", 1, "A: VENDOR. FIL"  
20 FIELD 1, 30 AS VENDNAME$, 20 AS ADDR$, 15 AS CITY$  
30 GET 1  
40 PRINT VENDNAME$, ADDR$, CITY$  
50 CLOSE 1
```

This example opens the file vendor.fil for random access, with fields defined in line 20. In line 30, the *GET* statement reads a record into the file buffer. Line 40 displays the information from the record just read. Line 50 closes the file.



# GET Statement (Graphics)

## Purpose:

To transfer graphics images from the screen.

## Syntax:

**GET** ( *x1, y1* ) - ( *x2, y2* ) , *array name*

## Comments:

The **PUT** and **GET** statements are used to transfer graphics images to and from the screen. **PUT** and **GET** make animation and high-speed object motion possible in either graphics mode.

The **GET** statement transfers the screen image bounded by the rectangle described by the specified points into the array. The rectangle is defined the same way as the rectangle drawn by the **LINE** statement using the ,**B** option.

The array is used simply as a place to hold the image, and can be of any type except string. It must be dimensioned large enough to hold the entire image. The contents of the array after a **GET** will be meaningless when interpreted directly (unless the array is of the type integer, as shown below).

The storage format in the array is as follows:

- o 2 bytes given x dimension in bits
- o 2 bytes given y dimension in bits
- o the array data itself

The data for each row of pixels is left-justified on a byte boundary. If less than a multiple of eight bits is stored, the rest of the byte will be filled out with zeros. The required array size in bytes is as follows:

$4 + \text{INT}((x * \text{bits per pixel} + 7) / 8) * y$

See the **SCREEN** statement for bits-per-pixel values for different screen modes.

The bytes-per-element of an array are as follows:

- o 2 for integer
- o 4 for single-precision
- o 8 for double-precision

The number of bytes required to get a 10 by 12 image into an integer array is  $4 + \text{INT}((10 * 2 + 7) / 8) * 12$ , or 40 bytes. An integer array with at least 20 elements is necessary.

If **OPTION BASE** equals zero, an integer array can be used to examine the x and y dimensions and the data. The x dimension is in element 0 of the array, and the y dimension is in element 1. Integers are stored low byte first, then high byte, but data is transferred high byte first (left-most), then low byte.

It is possible to get an image in one mode and put it in another, although the effect may be quite strange because of the way points are represented in each mode.

### Examples:

```
10 CLS: SCREEN 1
20 PSET(130, 120)
30 DRAW "U25; E7; R20; D32; L6; U12; L14"
40 DRAW "D12; L6": PSET(137, 102)
50 DRAW "U4; E4; R8; D8; L12"
60 PSET(137, 88)
70 DRAW "E4; R20; D32; G4": PAINT(139, 87)
80 DIM A(500)
90 GET (125, 130) - (170, 80), A
100 FOR I=1 TO 1000: NEXT I
110 PUT (20, 20), A, PSET
120 FOR I=1 TO 1000: NEXT I
130 GET (125, 130) - (170, 80), A
140 FOR I=1 TO 1000: NEXT I
150 PUT (220, 130), A, PRESET
```

# GOSUB...RETURN Statement

## Purpose:

To branch to, and return from, a subroutine.

## Syntax:

*GOSUB line number*

*RETURN [line number]*

## Comments:

*line number* is the first line number 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.

A **RETURN** statement in a subroutine causes GW-BASIC to return to the statement following the most recent **GOSUB** statement. A subroutine can contain more than one **RETURN** statement, should logic dictate a **RETURN** at different points in the subroutine.

Subroutines can appear anywhere in the program, but must be readily distinguishable from the main program.

To prevent inadvertent entry, precede the subroutine by a **STOP**, **END**, or **GOTO** statement to direct program control around the subroutine.

## Examples:

```
10 GOSUB 40
20 PRINT "BACK FROM SUBROUTINE"
30 END
40 PRINT "SUBROUTINE";
50 PRINT " IN";
60 PRINT " PROGRESS"
70 RETURN
RUN
SUBROUTINE IN PROGRESS
BACK FROM SUBROUTINE
Ok
```

The **END** statement in line 30 prevents re-execution of the subroutine.

# GOTO Statement

## Purpose:

To branch unconditionally out of the normal program sequence to a specified line number.

## Syntax:

**GOTO *line number***

## Comments:

***line number*** is any valid line number within the program.

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

## Examples:

```
10 READ R
20 PRINT "R ="; R;
30 A = 3.14*R^2
40 PRINT "AREA ="; A
50 GOTO 10
60 DATA 5, 7, 12
RUN
R = 5 AREA = 78.5
R = 7 AREA = 153.86
R = 12 AREA = 452.16
Out of data in 10
Ok
```

The "out of data" advisory is generated when the program attempts to read a fourth **DATA** statement (which does not exist) in line 60.

# HEX\$ Function

## Purpose:

To return a string which represents the hexadecimal value of the numeric argument.

## Syntax:

`v$=HEX$(x)`

## Comments:

**HEX\$** converts decimal values within the range of -32768 to +65535 into a hexadecimal string expression within the range of 0 to FFFF.

Hexadecimal numbers are numbers to the base 16, rather than base 10 (decimal numbers). Appendixes C and G in the GW-BASIC User's Guide contain more information on hexadecimal and their equivalents.

**x** is rounded to an integer before **HEX\$(x)** is evaluated. See the **OCT\$** function for octal conversions.

If **x** is negative, 2's (binary) complement form is used.

## Examples:

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

# IF Statement

## Purpose:

To make a decision regarding program flow based on the result returned by an expression.

## Syntax:

```
IF expression[, ] THEN statement(s)[, ] [ELSE statement(s)]  
IF expression[, ] GOTO line number[, ] ELSE statement(s)
```

## Comments:

If the result of *expression* is nonzero (logical true), the **THEN** or **GOTO** line number is executed.

If the result of *expression* is zero (false), the **THEN** or **GOTO** line number is ignored and the **ELSE** line number, if present, is executed. Otherwise, execution continues with the next executable statement. A comma is allowed before **THEN** and **ELSE**.

**THEN** and **ELSE** may be followed by either a line number for branching, or one or more statements to be executed.

**GOTO** is always followed by a line number.

If the statement does not contain the same number of **ELSE**'s and **THEN**'s line number, each **ELSE** is matched with the closest unmatched **THEN**. For example:

```
IF A=B THEN IF B=C THEN PRINT "A=C" ELSE PRINT "A < > C"
```

will not print "A < > C" when A < > B.

If an **IF . . THEN** statement is followed by a line number in the direct mode, an "Undefined line number" error results, unless a statement with the specified line number was previously entered in the indirect mode.

Because **IF . . THEN . . ELSE** is all one statement, the **ELSE** clause cannot be on a separate line. It must be all on one line.

## Nesting of IF Statements

**IF...THEN...ELSE** statements may be nested. Nesting is limited only by the length of the line. For example, the following is a legal statement:

```
100 IF X > Y THEN PRINT "GREATER" ELSE IF Y > X THEN&  
110 PRINT "LESS THAN"  
200 ELSE PRINT "EQUAL"
```

## Testing Equality

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 exact. Therefore, test against the range over which the accuracy of the value may vary.

For example, to test a computed variable A against the value 1.0, use the following statement:

```
IF ABS (A- 1. 0)<1. 0E- 6 THEN ...
```

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

## Examples:

The following statement gets record number N, if N is not zero.

```
200 IF N THEN GET#1, N
```

In the following example, a test determines if N is greater than 10 and less than 20. If N is within this range, DB is calculated and execution branches to line 300. If N is not within this range, execution continues with line 110.

```
100 IF(N<20) and (N>10) THEN DB=1979- 1: GOTO 300  
110 PRINT "OUT OF RANGE"
```

The next statement causes printed output to go either to the terminal or the line printer, depending on the value of a variable (IOFLAG). If IOFLAG is zero, output goes to the line printer; otherwise, output goes to the terminal.

```
210 IF IOFLAG THEN PRINT AS ELSE LPRINT AS
```

# INKEY\$ Variable

## Purpose:

To return one character read from the keyboard.

## Syntax:

`v$=INKEY$`

## Comments:

If no character is pending in the keyboard buffer, a null string (length zero) is returned.

If several characters are pending, only the first is returned. The string will be one or two characters in length.

Two character strings are used to return the extended codes described in Appendix C of the GW-BASIC User's Guide. The first character of a two character code is zero.

No characters are displayed on the screen, and all characters except the following are passed to the program:

**CTRL- BREAK**  
**CTRL- NUM- LOCK**  
**CTRL- ALT- DEL**  
**CTRL- PRTSC**  
**PRTSC**

## Examples:

```
10 CLS: PRINT"PRESS RETURN
20 TIMELIMIT% = 1000
30 GOSUB 1010
40 IF TIMEOUT% THEN PRINT "TOO LONG" ELSE PRINT "GOOD SHOW"
50 PRINT RESPONSE$
60 END
1000 REM TIMED INPUT SUBROUTINE
1010 RESPONSE$=""
1020 FOR N%=1 TO TIMELIMIT%
1030 A$=INKEY$: IF LEN(A$)=0 THEN 1060
1040 IF ASC(A$)=13 THEN TIMEOUT%=0: RETURN
1050 RESPONSE$=RESPONSE$+A$
1060 NEXT N%
1070 TIMEOUT%=1: RETURN
```

When this program is executed, and if the RETURN key is pressed before 1000 loops are completed, then **"GOOD SHOW"** is printed on the screen. Otherwise, **"TOO LONG"** is printed.



Since an **INKEYS** statement scans the keyboard only once, place **INKEYS** statements within loops to provide adequate response times for the operator.

## INP Function

### Purpose:

To return the byte read from machine port *n*.

### Syntax:

**INP**(*n*)

### Comments:

*n* represents a valid machine port number within the range of 0 to 65535.

The **INP** function is one way in which a peripheral device may communicate with a GW-BASIC program.

**INP** is the complementary function to the **OUT** statement.

### Examples:

**100 A=INP(56)**

Upon execution, variable A contains the value present on port 56. The number returned will be within the range of 0 to 255, decimal.

The assembly language equivalent to this statement is

```
MOV DX, 56  
IN AL, DX
```

# INPUT Statement

## Purpose:

To prepare the program for input from the terminal during program execution.

## Syntax:

```
INPUT[; ][prompt string; ] list of variables  
INPUT[; ][prompt string, ] list of variables
```

## Comments:

*prompt string* is a request for data to be supplied during program execution.

*list of variables* contains the variable(s) that stores the data in the prompt string.

Each data item in the prompt string must be surrounded by double quotation marks, followed by a semicolon or comma and the name of the variable to which it will be assigned. If more than one *variable* is given, data items must be separated by commas.

The data entered is assigned to the variable list. The number of data items supplied must be the same as the number of variables in the list.

The variable names in the list may be numeric or string variable names (including subscripted variables). The type of each data item input must agree with the type specified by the variable name.

Too many or too few data items, or the wrong type of values (for example, numeric instead of string), causes the message "**?Redo from start**" to be printed. No assignment of input values is made until an acceptable response is given.

A comma may be used instead of a semicolon after prompt string to suppress the question mark. For example, the following line prints the prompt with no question mark:

```
INPUT "ENTER BIRTHDATE", BS
```

If the prompt string is preceded by a semicolon, the RETURN key pressed by the operator is suppressed. During program execution, data on that line is displayed, and data from the next **PRINT** statement is added to the line.

When an **INPUT** statement is encountered during program execution, the program halts, the prompt string is displayed, and the operator types in the requested data. Strings that input to an **INPUT** statement need not be surrounded by quotation marks unless they contain commas or leading or trailing blanks.

When the operator presses the RETURN key, program execution continues.

**INPUT** and **LINE INPUT** statements have built-in **PRINT** statements. When an **INPUT** statement with a quoted string is encountered during program execution, the quoted string is printed automatically (see the **PRINT** statement).

The principal difference between the **INPUT** and **LINE INPUT** statements is that **LINE INPUT** accepts special characters (such as commas) within a string, without requiring double quotation marks, while the **INPUT** statement requires double quotation marks.

### Example 1:

To find the square of a number:

```
10 INPUT X
20 PRINT X "SQUARED IS" X^2
30 END
RUN
?
```

The operator types a number (5) in response to the question mark.

```
5 SQUARED IS 25
Ok
```

### Example 2:

To find the area of a circle when the radius is known:

```
10 PI=3.14
20 INPUT "WHAT IS THE RADIUS"; R
30 A=PI*R^2
40 PRINT "THE AREA OF THE CIRCLE IS"; A
50 PRINT
60 GOTO 20
RUN
WHAT IS THE RADIUS? 7.4
THE AREA OF THE CIRCLE IS 171.9464
```

Note that line 20 in the above example makes use of the built-in **PRINT** statement contained within **INPUT**.

# INPUT# Statement

## Purpose:

To read data items from a sequential file and assign them to program variables.

## Syntax:

*INPUT# file number, variable list*

## Comments:

*file number* is the number used when the file was opened for input.

*variable* list contains the variable names to be assigned to the items in the file.

The data items in the file appear just as they would if data were being typed on the keyboard in response to an **INPUT** statement.

The variable type must match the type specified by the variable name.

With **INPUT#**, no question mark is printed, as it is with **INPUT**.

## Numeric Values

For numeric values, leading spaces and line feeds are ignored. The first character encountered (not a space or line feed) is assumed to be the start of a number. The number terminates on a space, carriage return, line feed, or comma.

## Strings

If GW-BASIC is scanning the sequential data file for a string, leading spaces and line feeds are ignored.

If the first character is a double quotation mark ("), the string will consist of all characters read between the first double quotation mark and the second. A quoted string may not contain a double quotation mark as a character. The second double quotation mark always terminates the string.

If the first character of the string is not a double quotation mark, the string terminates on a comma, carriage return, line feed, or after 255 characters have been read.

If end of the file is reached when a numeric or string item is being **INPUT**, the item is terminated.

**INPUT#** can also be used with random files.

# INPUT\$ Function

## Purpose:

To return a string of **x** characters read from the keyboard, or from file number.

## Syntax:

**INPUT\$(x[, [#] *file number*])**

## Comments:

If the keyboard is used for input, no characters will appear on the screen. All control characters (except CTRL-BREAK) are passed through. CTRL-BREAK interrupts the execution of the **INPUT\$** function.

The **INPUT\$** function is preferred over **INPUT** and **LINE INPUT** statements for reading communications files, because all ASCII characters may be significant in communications. **INPUT** is the least desirable because input stops when a comma or carriage return is seen. **LINE INPUT** terminates when a carriage return is seen.

**INPUT\$** allows all characters read to be assigned to a string. **INPUT\$** will return **x** characters from the file number or keyboard.

For more information about communications, refer to Appendix F in the GW-BASIC User's Guide.

## Example 1:

The following example lists the contents of a sequential file in hexadecimal.

```
10 OPEN"I", 1, "DATA"
20 IF EOF(1) THEN 50
30 PRINT HEX$(ASC(INPUT$(1, #1)));
40 GOTO 20
50 PRINT
60 END
```

## Example 2:

In the following program, the program pauses, awaiting a keyboard entry of either P or S. Line 130 continues to loop back to line 100 if the input is other than P or S.

```
100 PRINT "TYPE P TO PROCEED OR S TO STOP"
110 XS=INPUT$(1)
120 IF XS="P" THEN 500
130 IF XS="S" THEN 700 ELSE 100
```

# INSTR Function

## Purpose:

To search for the first occurrence of string **y\$** in **x\$**, and return the position at which the string is found.

## Syntax:

**INSTR**( [**n**, ] **x\$**, **y\$**)

## Comments:

Optional offset **n** sets the position for starting the search. The default value for **n** is 1.

If **n** equals zero, the error message "**Illegal argument in line number**" is returned.

**n** must be within the range of 1 to 255. If **n** is out of this range, an "**Illegal Function Call**" error is returned.

**INSTR** returns 0 if:

- o **n**>LEN(**x\$**)
- o **x\$** is null
- o **y\$** cannot be found

If **y\$** is null, **INSTR** returns **n**.

**x\$** and **y\$** may be string variables, string expressions, or string literals.

## Examples:

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

The interpreter searches the string "ABCDFBXYZ" and finds the first occurrence of the character B at position 2 in the string. It then starts another search at position 4 (D) and finds the second match at position 6 (B). The last three characters are ignored, since all conditions set out in line 30 were satisfied.

# INT Function

## Purpose:

To truncate an expression to a whole number.

## Syntax:

`INT(x)`

## Comments:

Negative numbers return the next lowest number.

The `FIX` and `CINT` functions also return integer values.

## Examples:

```
PRINT INT(98.89)
98
Ok
```

```
PRINT INT(-12.11)
-13
Ok
```

# IOCTL Statement

## Purpose:

To allow GW-BASIC to send a "control data" string to a character device driver anytime after the driver has been opened.

## Syntax:

**IOCTL**[#]*file number, string*

## Comments:

*file number* is the file number open to the device driver.

*string* is a valid string expression containing characters that control the device.

**IOCTL** commands are generally 2 to 3 characters followed by an optional alphanumeric argument. An **IOCTL** string may be up to 255 bytes long, with commands within the string separated by semicolons.

## Examples:

If a user had installed a driver to replace lpt1, and that driver was able to set page length (the number of lines to print on a page before issuing a form feed), then the following lines would open the new lpt1 driver and set the page length to 66 lines:

```
OPEN "LPT1:" FOR OUTPUT AS #1
IOCTL #1, "PL66"
```

The following statements open lpt1 with an initial page length of 56 lines:

```
OPEN "\\DEV\\LPT1" FOR OUTPUT AS #1
IOCTL #1, "PL56"
```



# IOCTL\$ Function

## Purpose:

To allow GW-BASIC to read a "control data" string from an open character device driver.

## Syntax:

`IOCTL$([#]file number)`

## Comments:

*file number* is the file number open to the device.

The **IOCTL\$** function is generally used to get acknowledgement that an **IOCTL** statement succeeded or failed. It is also used to get device information, such as device width after an **IOCTL** statement requests it.

## Examples:

```
10 'GW is a possible command
20 'for get device width
30 OPEN "\DEV\MYLPT" AS#1
40 IOCTYL#1, "GW"
50 'Save it in WD
60 WD=VAL(IOCTL$(#1))
```

# KEY Statement

## Purpose:

To allow rapid entry of as many as 15 characters into a program with one keystroke by redefining GW-BASIC special function keys.

## Syntax:

*KEY key number, string expression*  
*KEY n, CHR\$(hexcode)+CHR\$(scan code)*  
*KEY ON*  
*KEY OFF*  
*KEY LIST*

## Comments:

*key number* is the number of the key to be redefined. *key number* may range from 1-20.

*string expression* is the key assignment. Any valid string of 1 to 15 characters may be used. If a string is longer than 15 characters, only the first 15 will be assigned. Constants must be enclosed in double quotation marks.

*scan code* is the variable defining the key you want to trap. Appendix H in the GW-BASIC User's Guide lists the scan codes for the keyboard keys.

*hex code* is the hexadecimal code assigned to the key shown below:

| Key:      | Hexcode:         |
|-----------|------------------|
| EXTENDED  | &H80             |
| CAPS LOCK | &H40             |
| NUM LOCK  | &H20             |
| ALT       | &H08             |
| CTRL      | &H04             |
| SHIFT     | &H01, &H02, &H03 |

Hexcodes may be added together, such as &H03, which is both shift keys.

Initially, the function keys are assigned the following special functions:

|    |              |     |                     |
|----|--------------|-----|---------------------|
| F1 | <b>LIST</b>  | F2  | <b>RUN↵</b>         |
| F3 | <b>LOAD"</b> | F4  | <b>SAVE"</b>        |
| F5 | <b>CONT↵</b> | F6  | <b>, "LPT1: " ↵</b> |
| F7 | <b>TRON↵</b> | F8  | <b>TROFF↵</b>       |
| F9 | <b>KEY</b>   | F10 | <b>SCREEN 000↵</b>  |

## Note

↵ (arrow) means that you do not have to press RETURN after each of these keys has been pressed.

Any one or all of the 10 keys may be redefined. When the key is pressed, the data assigned to it will be input to the program.

### **KEY key number, "string expression"**

Assigns the string expression to the specified key.

### **KEY LIST**

List all 10 key values on the screen. All 15 characters of each value are displayed.

### **KEY ON**

Displays the first six characters of the key values on the 25th line of the screen. When the display width is set at 40, five of the 10 keys are displayed. When the width is set at 80, all 10 are displayed.

### **KEY OFF**

Erases the key display from the 25th line, making that line available for program use. **KEY OFF** does not disable the function keys.

If the value for key number is not within the range of 1 to 10, or 15 to 20, an **Illegal function call** error occurs. The previous **KEY** assignment is retained.

Assigning a null string (length 0) disables the key as a function key.

When a function key is redefined, the **INKEYS** function returns one character of the assigned string per invocation. If the function key is disabled, **INKEYS** returns a string of two characters: the first is binary zero; the second is the key scan code.

### Examples:

```
10 KEY 1, "MENU"+CHR$(13)
```

Displays a menu selected by the operator each time key 1 is pressed.

```
1 KEY OFF
```

Turns off the key display.

```
10 DATA KEY1, KEY2, KEY3, KEY4, KEY5
20 FOR N=1 TO 5: READ SOFTKEYSS(n)
30 KEY N, SOFTKEYSS(I)
40 NEXT N
50 KEY ON
```

Displays new function keys on line 25 of the screen.

```
20 KEY 1, ""
```

Disables function key 1.

# KEY(n) Statement

## Purpose:

To initiate and terminate key capture in a GW-BASIC program.

## Syntax:

KEY(*n*) ON  
KEY(*n*) OFF  
KEY(*n*) STOP

## Comments:

*n* is a number from 1 to 20 that indicates which key is to be captured. Keys are numbered as follows:

| Key Number | Key   |
|------------|---|
| 1-10       | Function keys F1 through F10  |
| 11         | CURSOR-UP   |
| 12         | CURSOR-LEFT   |
| 13         | CURSOR-RIGHT  |
| 14         | CURSOR-DOWN   |
| 15-20      | Keys defined in the following format (see KEY statement):<br>KEY <i>n</i> , CHR\$(hexcode)+CHR\$(scan code) |

Execution of the KEY(*n*) ON statement is required to activate keystroke capture from the function keys or cursor control keys. When the KEY(*n*) ON statement is activated and enabled, GW-BASIC checks each new statement to see if the specified key is pressed. If so, GW-BASIC performs a GOSUB to the line number specified in the ON KEY(*n*) statement. An ON KEY(*n*) statement must precede a KEY(*n*) statement.

When KEY(*n*) OFF is executed, no key capture occurs and no keystrokes are retained.

If KEY(*n*) STOP is executed, no key capture occurs, but if a specified key is pressed, the keystroke is retained so that immediate keystroke capture occurs when a KEY(*n*) ON is executed.

For further information on key trapping, see the ON KEY (*n*) statement.

# KILL Command

## Purpose:

To delete a file from a disk.

## Syntax:

**KILL** *filename*

## Comments:

*filename* can be a program file, sequential file, or random-access data file.

**KILL** is used for all types of disk files, including program, random data, and sequential data files.

## Note

You must specify the filename's extension when using the **KILL** command. Remember that files saved in GW-BASIC are given the default extension .BAS.

If a **KILL** command is given for a file that is currently open, a "File already open" error occurs.

## Examples:

The following command deletes the GW-BASIC file data, and makes the space available for reallocation to another file:

```
200 KILL "DATA1. BAS"
```

The following command deletes the GW-BASIC file raining from the subdirectory dogs:

```
KILL "CATS\DOGS\RAINING. BAS"
```

# LEFT\$ Function

## Purpose:

To return a string that comprises the left-most n characters of **x\$**.

## Syntax:

**LEFT\$(x\$, n)**

## Comments:

**n** must be within the range of 0 to 255. If n is greater than **LEN(x\$)**, the entire string (**x\$**) will be returned. If n equals zero, the null string (length zero) is returned (see the **MID\$** and **RIGHT\$** substring functions).

## Example:

```
10 AS="BASIC"
20 BS=LEFT$(AS, 3)
30 PRINT BS
RUN
BAS
Ok
```

The left-most three letters of the string "BASIC" are printed on the screen.

# LEN Function

## Purpose:

To return the number of characters in **x\$**.

## Syntax:

**LEN(x\$)**

## Comments:

Nonprinting characters and blanks are counted.

Example:

**x\$** is any string expression.

```
10 XS="PORTLAND, OREGON"  
20 PRINT LEN(XS)  
16  
Ok
```

Note that the comma and space are included in the character count of 16.



# LET Statement

## Purpose:

To assign the value of an expression to a variable.

## Syntax:

**[LET]** *variable=expression*

## Comments:

The word **LET** is optional; that is, the equal sign is sufficient when assigning an expression to a variable name.

The **LET** statement is seldom used. It is included here to ensure compatibility with previous versions of BASIC that require it.

When using **LET**, remember that the type of the variable and the type of the expression must match. If they don't, a "Type mismatch" error occurs.

## Example 1:

The following example lets you have downward compatibility with an older system. If this downward compatibility is not required, use the second example, as it requires less memory.

```
110 LET D=12
120 LET E=12^2
130 LET F=12^4
140 LET SUM=D+E+F
```

## Example 2:

```
110 D=12
120 E=12^2
130 F=12^4
140 SUM=D+E+F
```

# LINE Statement

## Purpose:

To draw lines and boxes on the screen.

## Syntax:

`LINE [(x1,y1)]-(x2,y2) [, [attribute][, B[F]][, style]]`

## Comments:

`x1,y1` and `x2,y2` specify the end points of a line.

Resolution mode is determined by the `SCREEN` statement.

attribute specifies color or intensity of the displayed pixel (see the `COLOR` and `PALETTE` statements).

`B` (box) draws a box with the points `(x1,y1)` and `(x2,y2)` at opposite corners.

`BF` (filled box) draws a box (as `,B`) and fills in the interior with points.

## Note

If `attribute` is not specified, two commas must be used before `B` or `BF`.

`LINE` supports the additional argument `style`. `style` is a 16-bit integer mask used when putting down pixels on the screen. This is called line-styling.

Each time `LINE` stores a point on the screen, it uses the current circulating bit in `style`. If that bit is 0, no store will be done. If the bit is a 1, then a normal store is done. After each point, the next bit position in `style` is selected.

Since a 0 bit in `style` does not clear out the old contents, you may wish to draw a background line before a styled line, in order to force a known background.

`style` is used for normal lines and boxes, but is illegal for filled boxes.

If the `BF` parameter is used with the `style` parameter, a "Syntax" error will occur.

When out-of-range values are given in the `LINE` statement, the coordinates that are out of range are not visible on the screen. This is called line-clipping.

In the syntax shown here, the coordinate form `STEP (x offset, y offset)` is not shown. However, this form can be used wherever a coordinate is used.

In a **LINE** statement, if the relative form is used on the second coordinate, it is relative to the first coordinate.

After a **LINE** statement, the last referenced point is **x2, y2**.

The simplest form of **LINE** is the following:

**LINE - (xz, yz)**

This draws a line from the last point referenced to the point (**xz, yz**) in the foreground color.

### **Examples:**

**LINE (0, 100) - (639, 100)**

Draws a horizontal line which divides the screen in half from top to bottom in **SCREEN 2**.

**LINE (160, 0) - (160, 199)**

Draws a vertical line which divides the screen in half from left to right in **SCREEN 1**; makes a one-quarter/three-quarter division in **SCREEN 2**.

**LINE (0, 0) - (319, 199)**

Draws a diagonal line from the top left to lower right corner of the screen in **SCREEN 1**, and from the upper left corner to the center bottom of the screen in **SCREEN 2**.

**LINE (10, 10) - (20, 20) , 2**

Draws a line in color 2 if **SCREEN 1** is previously specified (see the **COLOR** statement).

```
10 CLS
20 LINE - (RND*319, RND*199) , RND*4
30 GOTO 20
```

Draw lines forever using random attributes.

```
10 FOR X=0 TO 319
20 LINE (X, 0) - (X, 199), X AND 1
30 NEXT
```

Draws an alternating pattern: line on, line off.

```
10 CLS
20 LINE - (RND*639, RND*199), RND*2, BF
30 GOTO 20
```

Draws lines all over the screen.

```
LINE (0, 0) - (100, 175), , B
```

Draws a square box in the upper left corner of the screen.

```
LINE (0, 0) - (100, 175), , BF
```

Draws the same box and fills it in.

```
LINE (0, 0) - (100, 175), 2, BF
```

Draws the same filled box in magenta in **SCREEN 1**.

```
LINE (0, 0) - (100, 350), , B
```

Draws the same box if **SCREEN 2** is specified.

```
400 SCREEN 1
410 LINE(160, 100) - (160, 199), , , &HCCCC
```

Draws a vertical dotted line down the center of the screen in **SCREEN 1**.

```
220 SCREEN 2
230 LINE(300, 100) - (400, 50), , B, &HAAAA
```

Draws a rectangle with a dotted line in **SCREEN 2**.

```
LINE (0, 0) - (160, 100), 3, , &HFF00
```

Draws a dotted line from the upper left corner to the screen center.

# LINE INPUT Statement

## Purpose:

To input an entire line (up to 255 characters) from the keyboard into a string variable, ignoring delimiters.

## Syntax:

`LINE INPUT [; ][prompt string; ]string variable`

## Comments:

*prompt string* is a string literal, displayed on the screen, that allows user input during program execution.

A question mark is not printed unless it is part of *prompt string*.

*string variable* accepts all input from the end of the prompt to the carriage return. Trailing blanks are ignored.

**LINE INPUT** is almost the same as the **INPUT** statement, except that it accepts special characters (such as commas) in operator input during program execution.

If a line-feed/carriage return sequence (this order only) is encountered, both characters are input and echoed. Data input continues.

If **LINE INPUT** is immediately followed by a semicolon, pressing the RETURN key will not move the cursor to the next line.

A **LINE INPUT** may be escaped by typing CTRL-BREAK. GW-BASIC returns to command level and displays **Ok**.

Typing **CONT** resumes execution at the **LINE INPUT** line.

## Example:

**100 LINE INPUT A\$**

Program execution pauses at line 100, and all keyboard characters typed thereafter are input to string A\$ until RETURN, CTRL-M, CTRL-C, or CTRL-BREAK is entered.

# LINE INPUT# Statement

## Purpose:

To read an entire line (up to 255 characters), without delimiters, from a sequential disk file to a string variable.

## Syntax:

`LINE INPUT# file number, string variable`

## Comments:

*file number* is the number under which the file was opened.

*string variable* is the variable name to which the line will be assigned.

`LINE INPUT#` reads all characters in the sequential file up to a carriage return. If a line feed/carriage return sequence (this order only) is encountered, it is input.

`LINE INPUT#` is especially useful if each line of a data file has been broken into fields, or if a BASIC program saved in ASCII mode is being read as data by another program.

## Examples:

```
10 OPEN "O", 1, "INFO"
20 LINE INPUT "CUSTOMER INFORMATION?"; C$
30 PRINT#1, C$
40 CLOSE 1
50 OPEN "I", 1, "INFO"
60 LINE INPUT#1, C$
70 PRINT C$
80 CLOSE 1
RUN
CUSTOMER INFORMATION?
```

If the operator enters

```
LINDA JONES 234, 4 MEMPHIS
```

then the program continues with the following:

```
LINDA JONES 234, 4 MEMPHIS
Ok
```

# LIST Command

## Purpose:

To list all or part of a program to the screen, line printer, or file.

## Syntax:

```
LIST [line number][-line number][, filename]  
LIST [line number-][, filename]
```

## Comments:

*line number* is a valid line number within the range of 0 to 65529.

If *filename* is omitted, the specified lines are listed to the screen.

Use the hyphen to specify a line range. If the line range is omitted, the entire program is listed.

*Line number*- lists that line and all higher numbered lines.

-*line number* lists lines from the beginning of the program through the specified line.

The period (.) can replace either *line number* to indicate the current line.

Any listing may be interrupted by pressing CTRL-BREAK.

## Examples:

**LIST**

Lists all lines in the program.

**LIST -20**

Lists lines 1 through 20.

**LIST 10-20**

Lists lines 10 through 20.

**LIST 20-**

Lists lines 20 through the end of the program.

# LLIST Command

## Purpose:

To list all or part of the program currently in memory to the line printer.

## Syntax:

```
LLIST [line number] [-line number]  
LLIST [line number-]
```

## Comments:

GW-BASIC always returns to command level after a **LLIST** is executed. The line range options for **LLIST** are the same as for **LIST**.

## Examples:

See the examples in the **LIST** statement.



# LOAD Command

## Purpose:

To load a file from diskette into memory.

## Syntax:

**LOAD** *filename*[, r]

## Comments:

*filename* is the filename used when the file was saved. If the extension was omitted, .BAS will be used.

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

If the **r** option is used with **LOAD**, the program runs after it is loaded, and all open data files are kept open.

**LOAD** with the **r** option lets you chain several programs (or segments of the same program). Information can be passed between the programs using the disk data files.

## Examples:

**LOAD "STRTRK", R**

Loads the file strtrk.bas and runs it, retaining all open files and variables from a previous program intact.

# LOC Function

## Purpose:

To return the current position in the file.

## Syntax:

*LOC(file number)*

## Comments:

*file number* is the file number used when the file was opened.

When transmitting or receiving a file through a communication port, **LOC** returns the number of characters in the input buffer waiting to be read. The default size for the input buffer is 256 characters, but can be changed with the */c:* option on the GW-BASIC command line. If there are more than 255 characters in the buffer, **LOC** returns 255. Since a string is limited to 255 characters, this practical limit alleviates the need to test for string size before reading data into it. If fewer than 255 characters remain in the buffer, then **LOC** returns the actual count.

With random disk files, **LOC** returns the record number just read from, or written to, with a **GET** or **PUT** statement.

With sequential files, **LOC** returns the number of 128-byte blocks read from, or written to, the file since it was opened. When the sequential file is opened for input, GW-BASIC initially reads the first sector of the file. In this case, the **LOC** function returns the character 1 before any input is allowed.

If the file was opened but no disk input/output was performed, **LOC** returns a zero.

## Examples:

```
200 IF LOC(1)>50 THEN STOP
```

The program stops after 51 records are read or written.

# LOCATE Statement

## Purpose:

To move the cursor to the specified position on the active screen. Optional parameters cause the cursor to blink on and off, and define the start and stop raster lines for the cursor. A raster line is the vertical or horizontal distance between two adjacent, addressable points on your screen.

## Syntax:

```
LOCATE [row][, [col][, [cursor][, [start] [, stop]]]
```

## Comments:

*row* is the screen line number, a numeric expression within the range of 1 to 25.

*col* is the screen column number, a numeric expression within the range of 1 to 40, or 1 to 80, depending upon screen width.

*cursor* is a boolean value indicating whether the cursor is visible; zero is off, nonzero is on.

*start* is the cursor start scan line, a numeric expression within the range of 0 to 31.

*stop* is the cursor stop scan line, a numeric expression within the range of 0 to 31.

When the cursor is moved to the specified position, subsequent **PRINT** statements begin placing characters at this location. Optionally, the **LOCATE** statement may be used to start the cursor blinking on or off, or change the size of the blinking cursor.

Any values entered outside of these ranges results in "**Illegal function call**" errors. Previous values are retained.

As you set up the parameters for the **LOCATE** statement, you may find that you do not wish to change one or more of the existing specifications. To omit a parameter from this **LOCATE** statement, insert a comma for the parameter that is being skipped. If the omitted parameter(s) occurs at the end of the statement, you do not have to type the comma.

If the start scan line parameter is given and the stop scan line parameter is omitted, stop assumes the start value.

## Examples:

### 10 LOCATE 1, 1

Moves cursor to the home position in the upper-left corner.

### 20 LOCATE , , 1

Makes the cursor visible. Its position remains unchanged. Notice that the first two parameters are not used. A comma has been inserted for each omitted parameter.

### 30 LOCATE , , , 7

Cursor position and visibility remain unchanged. Sets the cursor to appear at the bottom of the character starting and ending on scan line 7.

### 40 LOCATE 5, 1, 1, 0, 7

Moves the cursor to line 5, column 1, and turns the cursor on. The cursor covers an entire character cell, starting at scan line 0 and ending on scan line 7.

# LOCK Statement

## Purpose:

To restrict the access to all or part of a file that has been opened by another process. This is used in a multi-device environment, often referred to as a network or network environment.

## Syntax:

`LOCK [#]n [, [record number] [TO record number]]`

## Comments:

*n* is the number that was assigned to the file as it was originally numbered in the program.

*record number* is the number of the individual record that is to be locked. Or, if a range of records are to be locked, *record number* designates the beginning and ending record of the specified range.

The range of legal record numbers is 1 to 2<sup>32</sup> -1. The limit on record size is 32767 bytes.

The record range specified must be from lower to (the same or) higher record numbers.

If a starting record number is not specified, the record number 1 is assumed.

If an ending record number is not specified, then only the specified record is locked.

The following are examples of legal **LOCK** statements:

**LOCK #n**                      locks the entire file **n**

**LOCK #n, X**                locks record **X** only

**LOCK #n, TO Y**            locks records 1 through **Y**

**LOCK #n, X TO Y** locks records **X** through **Y**

With a random-access file, the entire opened file, or a range of records within an opened file, may be locked, thus denying access to those records to any other process which has also opened the file.

With a sequential access file that has been opened for input or output, the entire file is locked, regardless of any record range specified. This is not considered an error. The specification of a range in the **LOCK** statement regarding the sequential file will simply be disregarded.

The **LOCK** statement should be executed on a file or record range within a file before attempting to read or write to that file.

The locked file or record range should be unlocked before the file is closed. Failure to execute the **UNLOCK** statement can jeopardize future access to that file in a network environment.

It is expected that the time in which files or regions within files are locked will be short, and thus the suggested usage of the **LOCK** statement is within short-term paired **LOCK/UNLOCK** statements.

### Examples:

The following sequence demonstrates how the **LOCK/UNLOCK** statements should be used:

```
LOCK #1, 1 TO 4  
LOCK #1, 5 TO 8  
UNLOCK #1, 1 TO 4  
UNLOCK #1, 5 TO 8
```

The following example is illegal:

```
LOCK #1, 1 TO 4  
LOCK #1, 5 TO 8  
UNLOCK #1, 1 TO 8
```

# LOF Function

## Purpose:

To return the length (number of bytes) allocated to the file.

## Syntax:

`LOF(file number)`

## Comments:

*file number* is the number of the file that the file was opened under.

With communications files, **LOF** returns the amount of free space in the input buffers.

## Examples:

The following sequence gets the last record of the random-access file file.big, and assumes that the file was created with a default record length of 128 bytes:

```
10 OPEN "R", 1, "FILE.BIG"  
20 GET #1, LOF(1)/128
```

# LOG Function

## Purpose:

To return the natural logarithm of *x*.

## Syntax:

`LOG(x)`

## Comments:

*x* must be a number greater than zero.

**LOG(*x*)** is calculated in single precision, unless the `/d` switch is used when GW-BASIC is executed.

## Examples:

```
PRINT LOG(2)  
.6931471
```

```
PRINT LOG(1)  
0
```

# LPOS Function

## Purpose:

To return the current position of the lineprinter print head within the line printer buffer.

## Syntax:

**LPOS(*x*)**

## Comments:

**LPOS** does not necessarily give the physical position of the print head.

*x* is a dummy argument.

If the printer has less than the 132 characters-per-line capability, it may issue internal line feeds and not inform the computer internal line printer buffer. If this has happened, the value returned by **LPOS(*x*)** may be incorrect. **LPOS(*x*)** simply counts the number of printable characters since the last line feed was issued.

## Examples:

The following line causes a carriage return after the 60th character is printed on a line:

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



# LPRINT and LPRINT USING Statements

## Purpose:

To print data at the line printer.

## Syntax:

```
LPRINT [list of expressions][;]  
LPRINT USING string exp; list of expressions[;]
```

## Comments:

*list of expressions* consists of the string or numeric expression separated by semicolons.

*string expressions* is a string literal or variable consisting of special formatting characters. The formatting characters determine the field and the format of printed strings or numbers.

These statements are the same as **PRINT** and **PRINT USING**, except that output goes to the line printer. For more information about string and numeric fields and the variables used in them, see the **PRINT** and **PRINT USING** statements.

The **LPRINT** and **LPRINT USING** statements assume that your printer is an 80-character-wide printer.

To reset the number of characters that you can print across the printed page (assuming that your printer is wider than 80 characters), see the **WIDTH** statement.

# LSET and RSET Statements

## Purpose:

To move data from memory to a random-file buffer and left- or right-justify it in preparation for a PUT statement.

## Syntax:

*LSET string variable=string expression*  
*RSET string variable=string expression*

## Comments:

If string expression requires fewer bytes than were fielded to string variable, **LSET** left-justifies the string in the field, and **RSET** right-justifies the string (spaces are used to pad the extra positions).

If the string is too long for the field, characters are dropped from the right.

To convert numeric values to strings before the **LSET** or **RSET** statement is used, see the **MKIS**, **MKSS**, and **MKDS** functions.

**LSET** or **RSET** may also be used with a nonfielded string variable to left-justify or right-justify a string in a given field.

## Examples:

```
110 A$=SPACES(20)
120 RSET A$=N$
```

These two statements right-justify the string N\$ in a 20-character field. This can be valuable for formatting printed output.

# MERGE Command

## Purpose:

To merge the lines from an ASCII program file into the program already in memory.

## Syntax:

**MERGE** *filename*

## Comments:

*filename* is a valid string expression containing the filename. If no extension is specified, then GW-BASIC assumes an extension of .BAS.

The diskette is searched for the named file. If found, the program lines on the diskette are merged with the lines in memory. After the **MERGE** command, the merged program resides in memory, and GW-BASIC returns to the direct mode.

If the program being merged was not saved in ASCII code with the a option to the **SAVE** command, a "**Bad file mode**" error is issued. The program in memory remains unchanged.

If any line numbers in the file have the same number as lines in the program in memory, the lines from the file replace the corresponding lines in memory.

## Examples:

**MERGE** "SUBRTN"

Merges the file subrtn.bas with the program currently in memory, provided subrtn was previously saved with the a option. If some of the program lines are the same as those in the subrtn.bas file being merged, then the original program lines are replaced by the lines from subrtn.bas.

# MID\$ Function

## Purpose:

To return a string of *m* characters from *v\$* beginning with the *n<sup>th</sup>* character.

## Syntax:

`MID$(x$, n[, m])`

## Comments:

*n* must be within the range of 1 to 255.

*m* must be within the range of 0 to 255.

If *m* is omitted, or if there are fewer than *m* characters to the right of *n*, all rightmost characters beginning with *n* are returned.

If *n* > `LEN(x$)`, `MID$` function returns a null string.

If *m* equals 0, the `MID$` function returns a null string.

If either *n* or *m* is out of range, an "Illegal function call error" is returned.

For more information and examples, see the `LEFT$` and `RIGHT$` functions.

## Examples:

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

Line 30 concatenates (joins) the A\$ string to another string with a length of eight characters, beginning at position 8 within the B\$ string.

# MID\$ Statement

## Purpose:

To replace a portion of one string with another string.

## Syntax:

*MID\$(stringexp1, n[, m])=stringexp2*

## Comments:

Both *n* and *m* are integer expressions.

*stringexp1* and *stringexp2* are string expressions.

The characters in *stringexp1*, beginning at position *n*, are replaced by the characters in *stringexp2*.

The optional *m* refers to the number of characters from *stringexp2* that are used in the replacement. If *m* is omitted, all of *stringexp2* is used.

Whether *m* is omitted or included, the replacement of characters never goes beyond the original length of *stringexp1*.

## Examples:

```
10 A$="KANSAS CITY, MO"  
20 MID$(A$, 14)="KS"  
30 PRINT A$  
RUN  
KANSAS CITY, KS  
Ok
```

Line 20 overwrites "MO" in the A\$ string with "KS".

# MKDIR Command

## Purpose:

To create a subdirectory.

## Syntax:

**MKDI R** *pathname*

## Comments:

*pathname* is a string expression, not exceeding 63 characters, identifying the subdirectory to be created.

## Examples:

**MKDI R** "C: SALES\JOHN"

Creates the subdirectory john within the directory of sales.

# MKI\$, MKS\$, MKD\$ Functions

## Purpose:

To convert numeric values to string values.

## Syntax:

**MKI\$**(*integer expression*)

**MKS\$**(*single-precision expression*)

**MKD\$**(*double-precision expression*)

## Comments:

**MKI\$** converts an integer to a 2-byte string.

**MKS\$** converts a single-precision number to a 4-byte string.

**MKD\$** converts a double-precision number to an 8-byte string.

Any numeric value placed in a random file buffer with a **LSET** or a **RSET** statement must be converted to a string (see **CVI**, **CVS**, **CVD**, for the complementary functions).

These functions differ from **STR\$** because they change the interpretations of the bytes, not the bytes themselves.

## Examples:

```
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
```

# NAME Command

## Purpose:

To change the name of a disk file.

## Syntax:

*NAME old filename AS new filename*

## Comments:

*old filename* must exist and *new filename* must not exist; otherwise, an error results.

After a **NAME** command, the file exists on the same diskette, in the same disk location, with the new name.

## Examples:

**NAME "ACCTS" AS "LEDGER"**  
**Ok**

The file formerly named accts will now be named ledger. The file content and physical location on the diskette is unchanged.



# NEW Command

## Purpose:

To delete the program currently in memory and clear all variables.

## Syntax:

**NEW**

## Comments:

**NEW** is entered at command level to clear memory before entering a new program. GW-BASIC always returns to command level after a **NEW** is executed.

## Examples:

**NEW**  
**OK**

or

```
980 PRINT "Do You Wish To Quit (Y/N)
990 ANS$=INKEY$: IF ANS$=""THEN 990
1000 IF ANS$="Y" THEN NEW
1010 IF ANS$="N" THEN 980
1020 GOTO 990
```

# OCT\$ Function

## Purpose:

To convert a decimal value to an octal value.

## Syntax:

**OCT\$(x)**

## Comments:

**x** is rounded to an integer before **OCT\$(x)** is evaluated.

This statement converts a decimal value within the range of -32768 to +65535 to an octal string expression.

Octal numbers are numbers to the base 8 rather than base 10 (decimal numbers).

See the **HEX\$** function for hexadecimal conversion.

## Examples:

```
10 PRINT OCT$(18)
```

```
RUN
```

```
22
```

```
0k
```

Decimal 18 equals octal 22.

# ON COM(n), ON KEY(n), ON PEN, ON PLAY(n), ON STRIG(n), and ON TIMER(n) Statements

## Purpose:

To create an event trap line number for a specified event (such as communications, pressing function or cursor control keys, using the light pen, or using joysticks).

## Syntax:

*ON event specifier GOSUB line number*

## Comments:

The syntax shown sets up an event trap *line number* for the specified event. A line number of 0 disables trapping for this event.

Once trap line numbers have been set, event trapping itself can be controlled with the following syntax lines:

### *event specifier ON*

When an event is **ON**, and a nonzero line number is specified for the trap, then every time BASIC starts a new statement, it checks to see if the specified event has occurred. If it has, BASIC performs a **GOSUB** to the line specified in the **ON** statement.

### *event specifier OFF*

When an event is **OFF**, no trapping occurs and the event is not remembered, even if it occurs.

### *event specifier STOP*

When an event is stopped, no trapping can occur, but if the event happens, it is remembered so an immediate trap occurs when an event specifier **ON** is executed.

When a trap is made for a particular event, the trap automatically causes a stop on that event, so recursive traps can never take place.

The return from the trap routine automatically does an **ON** unless an explicit **OFF** has been performed inside the trap routine.

When an error trap takes place, this automatically disables all trapping.

Trapping will never take place when BASIC is not executing a program.

The following are valid values for *event specifier*:

|                               |  |
|-------------------------------|--|
| <b>COM(<i>n</i>)</b>          | <i>n</i> is the number of the COM channel (1 or 2).  |
| <b>KEY(<i>n</i>)</b>          | <i>n</i> is a function key number 1-20. 1 through 10 are the function keys F1 through F10. 11 through 14 are the cursor control keys as follows:<br><br>11= Cursor Up<br>12= Cursor Left<br>13= Cursor Right<br>14= Cursor Down<br><br>15-20 are user-defined keys.  |
| <b>PEN</b>                    | Since there is only one pen, no number is given.   |
| <b>PLAY(<i>n</i>)</b>         | <i>n</i> is an integer expression in the range of 1-32. Values outside this range result in "Illegal function call" errors.  |
| <b>STRIG(<i>n</i>)</b>        | <i>n</i> is 0, 2, 4 or 6. (0=trigger A1; 4=trigger A2; 2=trigger B1; 6=trigger B2).  |
| <b>TIMER(<i>n</i>)</b>        | <i>n</i> is a numeric expression within the range of 1 to 86,400. A value outside of this range results in an "Illegal function call" error.   |
| <b>RETURN<br/>line number</b> | <p>This optional form of <b>RETURN</b> is primarily intended for use with event trapping. The event-trapping routine may want to go back into the GW-BASIC program at a fixed line number while still eliminating the <b>GOSUB</b> entry that the trap created.</p> <p>Use of the nonlocal <b>RETURN</b> must be done with care. Any other <b>GOSUB</b>, <b>WHILE</b>, or <b>FOR</b> that was active at the time of the trap remains active.</p> <p>If the trap comes out of a subroutine, any attempt to continue loops outside the subroutine results in a "NEXT without FOR" error.</p> |

## Special Notes About Each Type of Trap

### COM Trapping:

Typically, the **COM** trap routine will read an entire message from the **COM** port before returning.

It is recommended that you not use the **COM** trap for single character messages, since at high baud rates the overhead of trapping and reading for each individual character may allow the interrupt buffer for **COM** to overflow.

### KEY Trapping:

Trappable keys 15 to 20 are defined by the following statement:

**KEY(*n*) , CHR\$[*hex code*]+CHR\$[*scan code*]**

*n* is an integer expression within the range of 15 to 20 defining the key to be trapped.

*hex code* is the mask for the latched key: (CAPS LOCK, NUM LOCK, ALT, CTRL, LEFT SHIFT, RIGHT SHIFT)

*scan code* is the number identifying one of the 83 keys to trap. Refer to Appendix H in the GW-BASIC User's Guide for key scan codes.

The appropriate bit in *hex code* must be set in order to trap a key that is shifted, control-shifted, or alt-shifted. *hex code* values are as follows:

| Mask        | Hexcode | Indicates that                 |
|-------------|---------|--------------------------------|
| EXTENDED    | &H80    | Key is extended                |
| CAPS LOCK   | &H40    | CAPS LOCK is active            |
| NUM LOCK    | &H20    | NUM LOCK is active             |
| ALT         | &H08    | The ALT key is pressed         |
| CTRL        | &H04    | The CTRL key is pressed        |
| LEFT SHIFT  | &H02    | The left SHIFT key is pressed  |
| RIGHT SHIFT | &H01    | The right SHIFT key is pressed |

For trapping shifted keys, you may use the value &H01, &H02, or &H03. The left and right SHIFT keys are coupled when &H03 is used.

Refer to the **KEY(*n*)** statement for more information.

No type of trapping is activated when GW-BASIC is in direct mode. Function keys resume their standard expansion meaning during input.

A key that causes a trap is not available for examination with the **INPUT** or **INKEYS** statement, so the trap routine for each key must be different if a different function is desired.

If CTRL-PRTS is trapped, the line printer echo toggle is processed first. Defining CTRL-PRTS as a key trap does not prevent characters from being echoed to the printer if CTRL-PRTS is pressed.

Function keys 1 through 14 are predefined. Therefore, setting scan codes 59-68, 72, 75, 77, or 80 has no effect.

### PLAY(n) Trapping

A **PLAY** event trap is issued only when playing background music (**PLAY"MB. .** ). **PLAY** event music traps are not issued when running in **MUSIC** foreground (default case, or **PLAY"MF. .** ).

Choose conservative values for *n*. An **ON PLAY(32) ..** statement will cause event traps so often that there will be little time to execute the rest of your program.

The **ON PLAY(n)** statement causes an event trap when the background music queue goes from *n* to *n-1* notes.

### STRIG Trapping

Using **STRIG(n) ON** activates the interrupt routine that checks the trigger status. Downstrokes that cause trapping will not set **STRIG(0)** , **STRIG(2)** , **STRIG(4)** , or **STRIG(6)** functions.

### TIMER(n) Trapping

An **ON TIMER(n)** event trapping statement is used with applications needing an internal timer. The trap occurs when *n* seconds have elapsed since the **TIMER ON** statement.

### Example 1:

This is a very simple terminal program.

```
10 REM "ON COM(n)" EXAMPLE
20 OPEN "COM1: 9600, 0, 7" AS #1
30 ON COM(1) GOSUB 80
40 COM(1) ON
50 REM TRANSMIT CHARACTERS FROM KEYBOARD
60 AS=INKEY$: IF AS="" THEN 50
70 PRINT #1, AS; : GOTO 50
80 REM DISPLAY RECEIVE CHARACTERS
90 ALL=LOC(1): IF ALL<1 THEN RETURN
100 BS=INPUT$(ALL, #1): PRINT BS; : RETURN
```

## Example 2:

Prevents a CTRL-BREAK or system reset during a program.

```
10 KEY 15, CHR$(4)+CHR$(70) REM Trap ^BREAK
20 KEY 16, CHR$(12)+CHR$(83) REM Trap system reset
30 ON KEY(15) GOSUB 1000
40 ON KEY(16) GOSUB 2000
50 KEY(15) ON
60 KEY(16) ON

. . .
1000 PRINT "I'm sorry, I can't let you do that"
1010 RETURN
2000 ATTEMPS=ATTEMPS+1
2010 ON ATTEMPS GOTO 2100, 2200, 2300, 2400, 2500
2100 PRINT "Mary had a little lamb":RETURN
2200 PRINT "Its fleece was white as snow":RETURN
2300 PRINT "And everywhere that Mary went":RETURN
2400 PRINT "The lamb was sure to go":RETURN
2500 KEY(16) OFF REM If they hit us once more...
2510 RETURN REM then BASIC dies...
```

## Example 3:

Displays the time of day on line 1 every minute.

```
10 ON TIMER(60) GOSUB 10000
20 TIMER ON
10000 OLDROW=CSRLIN REM Saves the current row
10010 OLDCOL=POS(0) REM Saves the current column
10020 LOCATE 1, 1: PRINT TIMES
10030 LOCATE OLDROW, OLDCOL REM Restores row and column
10040 RETURN
```

# ON ERROR GOTO Statement

## Purpose:

To enable error trapping and specify the first line of the error-handling subroutine.

## Syntax:

**ON ERROR GOTO *line number***

## Comments:

Once error trapping has been enabled, all errors detected by GW-BASIC, including direct mode errors, (for example, syntax errors) cause GW-BASIC to branch to the line in the program which begins the specified error-handling subroutine.

GW-BASIC branches to the line specified by the **ON ERROR** statement until a **RESUME** statement is found.

If *line number* does not exist, an "*Undefined line*" error results.

To disable error trapping, execute the following statement:

**ON ERROR GOTO 0**

Subsequent errors print an error message and halt execution.

An **ON ERROR GOTO 0** statement in an error-trapping subroutine causes GW-BASIC to stop and print the error message for the error that caused the trap. It is recommended 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 GW-BASIC error message is printed and execution terminated. Error trapping does not occur within the error-handling subroutine.

## Examples:

```
10 ON ERROR GOTO 1000
...
1000 A=ERR: B=ERL
1010 PRINT A, B
1020 RESUME NEXT
```

Line 1010 prints the type and location of the error on the screen (see the **ERR** and **ERL** variables).

Line 1020 causes program execution to continue with the line following the error.



# ON ... GOSUB and ON ... GOTO Statements

## Purpose:

To branch to one of several specified line numbers, depending on the value returned when an expression is evaluated.

## Syntax:

*ON expression GOTO line numbers*  
*ON expression GOSUB line numbers*

## Comments:

In the **ON ... GOTO** statement, the value of *expression* determines which line number in the list will be used for branching. For example, if the value is 3, the third line number in the list will be destination of the branch. If the value is a noninteger, the fractional portion is rounded.

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

If the value of *expression* is zero or greater than the number of items in the list (but less than or equal to 255), GW-BASIC continues with the next executable statement.

If the value of *expression* is negative, or greater than 255, an "Illegal function call" error occurs.

## Examples:

```
100 IF R<1 or R>4 then print "ERROR":END
```

If the integer value of R is less than 1, or greater than 4, program execution ends.

```
200 ON R GOTO 150, 300, 320, 390
```

If R=1, the program goes to line 150.

If R=2, the program branches to line 300 and continues from there. If R=3, the branch will be to line 320, and so on.

# OPEN Statement

## Purpose:

To establish input/output (I/O) to a file or device.

## Syntax:

```
OPEN mode, [#] file number, filename [, reclen]
```

```
OPEN filename [FOR mode] [ACCESS access] [lock] AS ...  
... [#] file number [LEN=reclen]
```

## Comments:

*filename* is the name of the file.

*mode* (first syntax) is a string expression with one of the following characters:

| Expression | Specifies |
|------------|-----------|
|------------|-----------|

|          |                          |
|----------|--------------------------|
| <b>O</b> | Sequential output mode   |
| <b>I</b> | Sequential input mode    |
| <b>R</b> | Random input/output mode |
| <b>A</b> | Position to end of file  |

*mode* (second syntax) determines the initial positioning within the file, and the action to be taken if the file does not exist. If the **FOR** mode clause is omitted, the initial position is at the beginning of the file. If the file is not found, one is created. This is the random I/O mode. That is, records may be read or written at any position within the file. The valid modes and actions taken are as follows:

|               |  |
|---------------|--|
| <b>INPUT</b>  | Position to the beginning of the file. A "File not found" error is given if the file does not exist. |
| <b>OUTPUT</b> | Position to the beginning of the file. If the file does not exist, one is created.                   |
| <b>APPEND</b> | Position to the end of the file. If the file does not exist, one is created.                         |
| <b>RANDOM</b> | Specifies random input or output mode.   |

*mode* must be a string constant. Do not enclose *mode* in double quotation marks. *access* can be one of the following:

## READ

## WRITE READ WRITE

*file number* is a number between 1 and the maximum number of files allowed. The number associates an I/O buffer with a disk file or device. This association exists until a **CLOSE** or **CLOSE** file number statement is executed.

*reclen* is an integer expression within the range of 1-32767 that sets the record length to be used for random files. If omitted, the record length defaults to 128-byte records.

When *reclen* is used for sequential files, the default is 128 bytes, and *reclen* cannot exceed the value specified by the **/s** switch.

A disk file must be opened before any disk I/O operation can be performed on that file. **OPEN** allocates a buffer for I/O to the file and determines the mode of access that is used with the buffer.

More than one file can be opened for input or random access at one time with different file numbers. For example, the following statements are allowed:

```
OPEN "B: TEMP" FOR INPUT AS #1  
OPEN "B: TEMP" FOR INPUT AS #2
```

However, a file may be opened only once for output or appending. For example, the following statements are illegal:

```
OPEN "TEMP" FOR OUTPUT AS #1  
OPEN "TEMP" FOR OUTPUT AS #2
```

### Note

Be sure to close all files before removing diskettes from the disk drives (see **CLOSE** and **RESET**).

A device may be one of the following:

|                     |                         |
|---------------------|-------------------------|
| <b>A: , B: , C:</b> | Disk Drive              |
| <b>KYBD:</b>        | Keyboard (input only)   |
| <b>SCRN:</b>        | Screen (output only)    |
| <b>LPT1:</b>        | Line Printer 1          |
| <b>LPT2:</b>        | Line Printer 2          |
| <b>LPT3:</b>        | Line Printer 3          |
| <b>COM1:</b>        | RS-232 Communications 1 |
| <b>COM2:</b>        | RS-232 Communications 2 |

For each device, the following **OPEN** modes are allowed:

|              |                               |
|--------------|-------------------------------|
| <b>KYBD:</b> | Input Only                    |
| <b>SCRN:</b> | Output Only                   |
| <b>LPT1:</b> | Output Only                   |
| <b>LPT2:</b> | Output Only                   |
| <b>LPT3:</b> | Output Only                   |
| <b>COM1:</b> | Input, Output, or Random Only |
| <b>COM2:</b> | Input, Output, or Random Only |

Disk files allow all modes.

When a disk file is opened for **APPEND**, the position is initially at the end of the file, and the record number is set to the last record of the file (**LOF(x) / 128**). **PRINT**, **WRITE**, or **PUT** then extends the file. The program may position elsewhere in the file with a **GET** statement. If this is done, the mode is changed to random and the position moves to the record indicated.

Once the position is moved from the end of the file, additional records may be appended to the file by executing a **GET #x, LOF(x) / reclen** statement. This positions the file pointer at the end of the file in preparation for appending.

Any values entered outside of the ranges given result in "**Illegal function call**" errors. The files are not opened.

If the file is opened as **INPUT**, attempts to write to the file result in "**Bad file mode**" errors.

If the file is opened as **OUTPUT**, attempts to read the file result in "**Bad file mode**" errors.

Opening a file for **OUTPUT** or **APPEND** fails, if the file is already open in any mode.

Since it is possible to reference the same file in a subdirectory via different paths, it is nearly impossible for GW-BASIC to know that it is the same file simply by looking at the path. For this reason, GW-BASIC does not let you open the file for **OUTPUT** or **APPEND** if it is on the same disk, even if the path is different. For example if mary is your working directory, the following statements all refer to the same file:

```
OPEN "REPORT"  
OPEN "\SALES\MARY\REPORT"  
OPEN ". . \MARY\REPORT"  
OPEN ". . \. . \MARY\REPORT"
```

At any one time, it is possible to have a particular diskette filename open under more than one file number. Each file number has a different buffer, so several records from the same file may be kept in memory for quick access. This allows different modes to be used for different purposes; or, for program clarity, different file numbers to be used for different modes of access.

If the **LEN=reclen** option is used, **reclen** may not exceed the value set by the **/s: reclen** switch option in the command line.

In a network environment, the use of the **OPEN** statement is based upon two different sets of circumstances:

- o Devices may be shared on a network for specific purposes only, so that **OPEN** statements may be restricted to specific modes among those which might be requested, such as: **INPUT**, **OUTPUT**, **APPEND**, and default (Random).
- o Files may be restricted by the implementation of an **OPEN** statement which allows a process to specify an access to the successfully opened file. The access determines a guaranteed exclusivity range on that file by the process while the **OPEN** statement is in effect.

**lock** can be one of the following:

- SHARED** "deny none" mode. No restrictions are placed on the read/write accessibility of the file to another process, except that the default mode is not allowed by any of the modes including **SHARED**.
- LOCK READ** "deny read" mode. Once a file is opened with the **LOCK READ** access, no other process is granted read-access to that file. An attempt to open a file with this access will be unsuccessful, if the file is currently open in default mode or with a read access.
- LOCK WRITE** "deny write" mode. A file successfully opened with **LOCK WRITE** access may not be opened for a write access by another process. An attempt to open a file with this access will be unsuccessful if the file has been opened in default mode, or with a write access by another process.
- LOCK READ** "deny all" or "exclusive" mode. If a file is successfully **WRITE** opened with this access, the process has exclusive access to the file. A file that is currently open in this mode cannot be opened again in any mode by any process.
- default** "compatibility" mode, in which the compatibility with other BASICS is understood. No access is specified. The file may be opened any number of times by a process, provided that the file is not currently opened by another process. Other processes are denied access to the file while it is open under default access. Therefore, it is functionally exclusive.

When an attempt is made to open a file that has been previously accessed by another process, the error "**Permission Denied**" will result. An example of a situation generating this error is when a process attempts to **OPEN SHARED** on a file that is already **OPEN LOCK READ WRITE** by another process.

If an **OPEN** statement fails because the mode is incompatible with networkinstalled sharing access to a device, the error generated is "**Path/File Access Error**." An example of this is when a process is attempting to **OPEN** a file for output on a directory that has been shared for read only.

For more information about using files in a networking environment, see the **LOCK** and **UNLOCK** statements.

### Examples:

```
10 OPEN "I", 2, "INVEN"
```

Opens file 2, inven, for sequential input.

# OPEN "COM(n) Statement

## Purpose:

To allocate a buffer to support RS-232 asynchronous communications with other computers and peripheral devices in the same manner as **OPEN** for disk files.

## Syntax:

```
OPEN "COM[ n ] : [ speed ] [ , parity ] [ , data ] [ , stop ] [ , RS ] [ , CS[ n ] ] [ , DS[ n ] ]  
[ , CD[ n ] ] [ , LF ] [ , PE ] " AS [ # ] filename [ LEN=number ]
```

## Comments:

**COM[ *n* ]** is a valid communications device: com1: or com2:.

***speed*** is a literal integer specifying the transmit/receive baud rate.

Valid speeds are as follows:

75, 110, 150, 300, 600, 1200, 1800, 2400, 4800, and 9600. The default is 300 bps.

***parity*** is a one-character literal specifying the parity for transmitting and receiving.

Valid characters specifying parity are as follows:

**S** (=SPACE) Parity bit always transmitted and received as space (0 bit).

**M** (=MARK) Parity bit always transmitted and received as mark (1 bit).

**O** (=ODD) Odd transmit parity; odd receive parity checking.  
Default is even.

**E** (=EVEN) Even transmit parity; even receive parity checking.  
Even is default.

**N** (=NONE) No transmit parity. No receive parity checking.

***data*** is a literal integer indicating number of transmit/receive data bits.

Valid values for the number of data bits are 4, 5, 6, 7, or 8, the default is 7 bits.

## Note

Four data bits with no parity is illegal; eight data bits with any parity is illegal.

***stop*** is a literal integer expression returning a valid file number.

Valid values for number of stop bits are 1 and 2. If omitted, 75 and 110 bps transmit two stop bits. All others transmit one stop bit.

**filenum** is a number between 1 and the maximum number of files allowed. A communications device may be opened to only one file number at a time.

The **filenum** is associated with the file for as long as the file is open, and is used to refer other COM I/O statements to the file.

Any coding errors within the filename string result in "Bad file name" errors. An indication as to which parameters are in error is not given.

**number** is the maximum number of bytes which can be read from the communications buffer when using **GET** or **PUT** default of 128 bytes.

A "Device timeout" error occurs if "data set ready" (DSR) is not detected.

The **RS**, **CS**, **DS**, **CD**, **LF**, and **PE** options affect the line signals as follows:

| Option       | Function                         |
|--------------|----------------------------------|
| <b>RS</b>    | suppresses RTS (request to send) |
| <b>CS[n]</b> | controls CTS (clear to send)     |
| <b>DS[n]</b> | controls DSR (data set ready)    |
| <b>CD[n]</b> | controls CD (carrier detect)     |
| <b>LF</b>    | sends a line feed at each return |
| <b>PE</b>    | enables parity checking          |

**n** is the number of milliseconds to wait (0-65535) for that signal before a device timeout error occurs. Defaults are: CS1000, DS1000, and CD0. If **RS** was specified then CS0 is the default. If **n** is omitted, then timeout is set to 0.

See Appendix F in the GW-BASIC User's Guide for more information about communications.



## Examples:

In the following, File 1 is opened for communications with all defaults: speed at 300 bps, even parity, seven data bits, and one stop bit.

```
10 OPEN "COM1:" AS 1
```

In the following, File 2 is opened for communications at 2400 bps. Parity and number of data bits are defaulted.

```
20 OPEN "COM1: 2400" AS #2
```

In the following, File 1 is opened for asynchronous I/O at 1200 bits/second. No parity is to be produced or checked.

```
10 OPEN "COM1: 1200, N, 8" AS #1
```

## OPTION BASE Statement

### Purpose:

To declare the minimum value for array subscripts.

### Syntax:

```
OPTION BASE n
```

### Comments:

*n* is 1 or 0. The default base is 0.

If the statement **OPTION BASE 1** is executed, the lowest value an array subscript can have is 1.

An array subscript may never have a negative value.

**OPTION BASE** gives an error only if you change the base value. This allows chained programs to have **OPTION BASE** statements as long as the value is not changed from the initial setting.

### Note

You must code the **OPTION BASE** statement before you can define or use any arrays. If an attempt is made to change the option base value after any arrays are in use, an error results.

# OUT Statement

## Purpose:

To send a byte to a machine output port.

## Syntax:

**OUT** *h,j*

## Comments:

*h* and *j* are integer expressions. *h* may be within the range of 0 to 65535. *j* may be within the range of 0 to 255. *h* is a machine port number, and *j* is the data to be transmitted.

**OUT** is the complementary statement to the **INP** function.

## Examples:

**100 OUT 12345, 225**

Outputs the decimal value 225 to port number 12345. In assembly language, this is equivalent to the following:

**MOV DX, 12345**

**MOV AL, 255**

**OUT DX, AL**

# PAINT Statement

## Purpose:

To fill in a graphics figure with the selected attribute.

## Syntax:

**PAINT** (*x start*, *y start*) [, *paint attribute*] [, *border attribute*] [, *bckgrnd attribute*]

## Comments:

The **PAINT** statement fills in an arbitrary graphics figure of the specified border attribute with the specified paint attribute. If *paint attribute* is not given, it will default to the foreground attribute (3 or 1). *border attribute* defaults to *paint attribute*. See the **COLOR** and **PALETTE** statements for more information.

**PAINT** must start on a nonborder point, otherwise, **PAINT** will have no effect.

**PAINT** can fill any figure, but painting jagged edges or very complex figures may result in an "Out of memory" error. The **CLEAR** statement may be used to increase the amount of stack space available.

Points that are specified outside the limits of the screen will not be plotted and no error will occur.

See the **SCREEN** statement for a description of the different screen modes.

## Paint Tiling

**PAINT** tiling is similar to **LINE** styling. Like **LINE**, **PAINT** looks at a tiling mask each time a point is put down on the screen.

If *paint attribute* is omitted, the standard foreground attribute is used.

If *paint attribute* is a numeric formula, then the number must be a valid color, and it is used to paint the area as before.

If *paint attribute* is a string formula, then tiling is performed as follows:

The tile mask is always eight bits wide and may be from 1 to 64 bytes long. Each byte in the tile string masks eight bits along the x axis when putting down points. Each byte of the tile string is rotated as required to align along the y axis, such that:

**tile\_byte\_mask=y MOD tile\_length**

where **y** is the position of the graphics cursor on the y-axis.

**tile\_length** is the length in bytes of the tile string defined by the user (1 to 64 bytes).

This is done so that the tile pattern is replicated uniformly over the entire screen (as if a **PAINT (0,0) . .** were used).

**x Increases                      →                      Bit of Tile Byte**

**x, y      8 7 6 5 4 3 2 1**

|              |                 |   |
|--------------|-----------------|---|
| <b>0, 0</b>  | x x x x x x x x | <b>Tile byte 1</b>                              |
| <b>0, 1</b>  | x x x x x x x x | <b>Tile byte 2</b>                              |
| <b>0, 2</b>  | x x x x x x x x | <b>Tile byte 3</b>                              |
| <b>⋮</b>     | <b>⋮</b>        | <b>⋮</b>  |
| <b>0, 63</b> | x x x x x x x x | <b>Tile byte 64</b><br><b>(maximum allowed)</b> |

In high-resolution mode (**SCREEN 2**), the screen can be painted with Xs by the following statement:

**PAINT (320, 100), CHR\$(&H81)+CHR\$(&H42)+CHR\$(&H24)+CHR\$(&H18)+CHR\$(&H18)+CHR\$(&H24)+CHR\$(&H81)**

This appears on the screen as follows:

**x increases →**

|             |                 |                        |                    |
|-------------|-----------------|------------------------|--------------------|
| <b>0, 0</b> | x             x | <b>CHR\$(&amp;H81)</b> | <b>Tile byte 1</b> |
| <b>0, 1</b> | x           x   | <b>CHR\$(&amp;H42)</b> | <b>Tile byte 2</b> |
| <b>0, 2</b> | x       x       | <b>CHR\$(&amp;H24)</b> | <b>Tile byte 3</b> |
| <b>0, 3</b> | x x             | <b>CHR\$(&amp;H18)</b> | <b>Tile byte 4</b> |
| <b>0, 4</b> | x x             | <b>CHR\$(&amp;H18)</b> | <b>Tile byte 5</b> |
| <b>0, 5</b> | x       x       | <b>CHR\$(&amp;H24)</b> | <b>Tile byte 6</b> |
| <b>0, 6</b> | x         x     | <b>CHR\$(&amp;H42)</b> | <b>Tile byte 7</b> |
| <b>0, 7</b> | x             x | <b>CHR\$(&amp;H81)</b> | <b>Tile byte 8</b> |

Since there are two bits per pixel in medium-resolution mode (**SCREEN 1**), each byte of the tile pattern only describes four pixels. In this case, every two bits of the tile byte describes one of the four possible colors associated with each of the four pixels to be put down.

*bckgrnd attribute* specifies the background tile pattern or color byte to skip when checking for boundary termination. *bckgrnd attribute* is a string formula returning one character. When omitted, the default is **CHRS(0)**.

Occasionally, you may want to paint tile over an already painted area that is the same color as two consecutive lines in the tile pattern. **PAINT** quits when it encounters two consecutive lines of the same color as the point being set (the point is surrounded). It is not possible to draw alternating blue and red lines on a red background without *bckgrnd attribute*. **PAINT** stops as soon as the first red pixel is drawn. By specifying red (**CHRS(&HAA)**) as the background attribute, the red line is drawn over the red background.

You cannot specify more than two consecutive bytes in the tile string that match the background attribute. Specifying more than two results in an "Illegal function call" error.

### Examples:

```
10 CLS
20 SCREEN 1
30 LINE (0, 0) - (100, 150), 2, B
40 PAINT (50, 50), 1, 2
50 LOCATE 20, 1
```

The **PAINT** statement in line 40 fills in the box drawn in line 30 with color 1.

# PALETTE, PALETTE USING Statements

## Purpose:

Changes one or more of the colors in the palette

## Syntax:

**PALETTE** [*attribute, color*]

**PALETTE USING** *integer-array-name* (*arrayindex*)

## Comments:

The **PALETTE** statement works only for systems equipped with the IBM (R) Enhanced Graphics Adapter (EGA). A GW-BASIC palette contains a set of colors, with each color specified by an *attribute*. Each *attribute* is paired with an actual display *color*. This *color* determines the actual visual color on the screen, and is dependent on the setting of your screen mode and your actual physical hardware display.

**PALETTE** with no arguments sets the palette to a known initial setting. This setting is the same as the setting when colors are first initialized.

If arguments are specified, *color* will be displayed whenever *attribute* is specified in any statement that specifies a color. Any color changes on the screen occur immediately. Note that when graphics statements use color arguments, they are actually referring to attributes and not actual colors. **PALETTE** pairs attributes with actual colors.

For example, assume that the current palette consists of *colors 0, 1, 2, and 3*. The following **DRAW** statement:

**DRAW "C3L100"**

selects attribute 3, and draws a line of 100 pixels using the color associated with the attribute 3, in this case, also 3. If the statement:

**PALETTE 3, 2**

is executed, then the color associated with attribute 3 is changed to color 2. All text or graphics currently displayed on the screen using attribute 3 are instantaneously changed to color 2. All text or graphics subsequently displayed with attribute 3 will also be displayed in color 2. The new palette of *colors* will contain 0, 1, 2, and 2.

With the **USING** option, all entries in the palette can be modified in one **PALETTE** statement. The *integer-array-name* argument is the name of an integer array, and the *arrayindex* specifies the index of the first array element in the *integer-array-name* to use in setting your palette. Each attribute in the palette is assigned a corresponding color from this integer array. The array must be dimensioned large enough to set all the palette entries after *arrayindex*.

For example, if you are assigning colors to all 16 attributes, and the index of the first array element given in your **PALETTE USING** statement is 5, then the array must be dimensioned to hold at least 20 elements (since the number of elements from 5-20, inclusive, is 16):

```
DIM PAL%(20)  
...  
PALETTE USING PAL%(5)
```

If the *color* argument in an array entry is -1, then the mapping for the associated *attribute* is not changed. All other negative numbers are illegal values for *color*.

You can use the color argument in the **COLOR** statement to set the default text color. (Remember that color arguments in other BASIC statements are actually what are called *attributes* in this discussion.) This color argument specifies the way that text characters appear on the display screen. Under a common initial palette setting, points colored with the *attribute 0* appear as black on the display screen. Using the **PALETTE** statement, you could, for example, change the mapping of *attribute 0* from black to white.

Remember that a **PALETTE** statement executed without any parameters assigns all *attributes* their default *colors*.

The following table lists *attribute* and *color* ranges for various monitor types and screen modes:

**Table 1 - SCREEN Color and Attribute Ranges**

| SCREEN Mode | Monitor Attached            | Adapter Range    | Attribute Range   | Color             |
|-------------|-----------------------------|------------------|-------------------|-------------------|
| 0           | Monochrome                  | MDPA             | NA                | NA                |
|             | Monochrome                  | EGA              | 0-15              | 0-2               |
|             | Color                       | CGA              | NA                | 0-31 <sup>a</sup> |
|             | Color/Enhanced <sup>d</sup> | EGA              | 0-31 <sup>a</sup> | 0-15              |
| 1           | Color                       | CGA              | NA                | 0-3               |
|             | Color/Enhanced <sup>d</sup> | EGA              | 0-3               | 0-15              |
| 2           | Color                       | CGA              | NA                | 0-1               |
|             | Color/Enhanced <sup>d</sup> | EGA              | 0-1               | 0-15              |
| 7           | Color/Enhanced <sup>d</sup> | EGA              | 0-15              | 0-15              |
| 8           | Color/Enhanced <sup>d</sup> | EGA              | 0-15              | 0-15              |
| 9           | Enhanced <sup>d</sup>       | EGA <sup>b</sup> | 0-3               | 0-15              |
|             | Enhanced <sup>d</sup>       | EGA <sup>c</sup> | 0-15              | 0-63              |
| 10          | Monochrome                  | EGA              | 0-3               | 0-8               |

<sup>a</sup> Attributes 16-31 refer to blinking versions of colors 0-15

<sup>b</sup> With 64K of EGA memory

<sup>c</sup> With greater than 64K of EGA memory

<sup>d</sup> IBM Enhanced Color Display

NA = Not Applicable

CGA = IBM Color Graphics Adapter

EGA = IBM Enhanced Graphics Adapter

MDPA = IBM Monochrome Display and Printer Adapter

See the [SCREEN](#) statement reference page for the list of colors available for various [SCREEN](#) mode, monitor, and graphics adapter combinations.



## Examples:

|                     |  |
|---------------------|--|
| PALETTE 0, 2        | ' Changes all points colored with attribute 0<br>' to color 2  |
| PALETTE 0, - 1      | ' Does not modify the palette  |
| PALETTE USING A%(0) | ' Changes each palette entry. Since the<br>' array is initialized to zero when it<br>' is first declared, all attributes are<br>' now mapped to display color zero. The<br>' screen will now appear as one single<br>' color. However, it will still be<br>' possible to execute BASIC statements. |
| PALETTE             | ' Sets each palette entry to its appropriate<br>' initial display color. Actual initial colors<br>' depend on your screen hardware configuration.  |

# PCOPY Command

## Purpose:

To copy one screen page to another in all screen modes.

## Syntax:

*PCOPY sourcepage, destinationpage*

## Comments:

The *sourcepage* is an integer expression in the range 0 to n, where n is determined by the current video-memory size and the size per page for the current screen mode.

The *destinationpage* has the same requirements as the *sourcepage*.

For more information, see **CLEAR** and **SCREEN**.

## Examples:

This copies the contents of page 1 to page 2:

**PCOPY 1, 2**

# PEEK Function

## Purpose:

To read from a specified memory location.

## Syntax:

**PEEK**(*a*)

## Comments:

Returns the byte (decimal integer within the range of 0 to 255) read from the specified memory location *a*. *a* must be within the range of 0 to 65535.

The **DEF SEG** statement last executed determines the absolute address that will be peeked into.

**PEEK** is the complementary function to the **POKE** statement.

## Examples:

**10 A=PEEK(&H5A00)**

The value of the byte, stored in user-assigned hex offset memory location 5A00 (23040 decimal), will be stored in the variable A.

# PEN Statement and Function

## Purpose:

To read the light pen.

## Syntax:

As a statement:

PEN ON  
PEN OFF  
PEN STOP

As a function:

**x** = PEN(*n*)

## Comments:

**x** is the numeric variable receiving the **PEN** value.

*n* is an integer within the range of 0 to 9.

**PEN ON** enables the **PEN** read function.

**PEN OFF** disables the **PEN** read function.

**PEN STOP** disables trapping. It remembers the event so immediate trapping occurs when **PEN ON** is executed.

**x** = PEN(*n*) reads the light pen coordinates.

The **PEN** function is initially off. A **PEN ON** statement must be executed before any **PEN** read function calls can be made, or a **PEN** read function call results in an "Illegal function call" error.

Light pen coordinates:

- n = 0**      If **PEN** was down since last poll, returns -1; if not, returns 0.
- n = 1**      Returns the x-pixel coordinate when **PEN** was last activated. The range is within 0 to 319 for medium resolution; 0 to 639, for high resolution.
- n = 2**      Returns the y-pixel coordinate when **PEN** was last activated. The range is within 0 to 199.
- n = 3**      Returns the current **PEN** switch value. Returns -1 if down; 0 if up.
- n = 4**      Returns the last known valid x-pixel coordinate. The range is within 0 to 319 for medium resolution; or 0 to 639 for high resolution.
- n = 5**      Returns the last known valid y-pixel coordinate. The range is within 0 to 199.
- n = 6**      Returns the character row position when **PEN** was last activated. The range is within 1 to 24.
- n = 7**      Returns the character column position when **PEN** was last activated. The range is within 1 to 40, or 1 to 80, depending on the screen width.
- n = 8**      Returns the last known valid character row. The range is within 1 to 24.
- n = 9**      Returns the last known valid character column position. The range is within 1 to 40, or 1 to 80, depending on the screen width.

For execution speed improvements, turn the pen off with a **PEN OFF** statement for those programs not using the light pen.

When the pen is in the border area of the screen, the values returned will be inaccurate.

### Examples:

```
50 PEN ON
60 FOR I=1 to 500
70 X=PEN(0) : X1=PEN(3)
80 Print X, X1
90 NEXT
100 PEN OFF
```

This example prints the pen value since the last poll and the current value.

# PLAY Statement

## Purpose:

To play music by embedding a music macro language into the string data type.

## Syntax:

*PLAY string expression*

## Comments:

The single-character commands in **PLAY** are as follows:

|                         |   |
|-------------------------|---|
| <b>A-G</b> [# , + , - ] | <b>A-G</b> are notes. # or + following a note produces a sharp; - produces a flat.<br><br>Any note followed by #,+ or - must refer to a black key on a piano.   |
| <b>L(n)</b>             | Sets the length of each note. L4 is a quarter note, L1 is a whole note, and so on. n may be from 1 to 64.<br><br>Length may also follow the note to change the length for that note only. A16 is equivalent to L16A.  |
| <b>MF</b>               | Music foreground. <b>PLAY</b> and <b>SOUND</b> statements are to run in foreground. That is, each subsequent note or sound is not started until the previous note or sound is finished. This is the initial default.  |
| <b>MB</b>               | Music background. <b>PLAY</b> and <b>SOUND</b> statements are to run in background. That is, each note or sound is placed in a buffer allowing the BASIC program to continue execution while music plays in the background. As many as 32 notes (or rests) can be played in background at one time. |
| <b>MN</b>               | Music normal. Each note plays seven-eighths of the time determined by L (length).   |
| <b>ML</b>               | Music legato. Each note plays the full period set by L.   |
| <b>MS</b>               | Music staccato. Each note plays three-quarters of the time determined by L.   |
| <b>N(n)</b>             | Play note <b>n</b> . <b>n</b> may range from 0 to 84. In the 7 possible octaves, there are 84 notes. <b>n</b> set to 0 indicates a rest.  |
| <b>O(n)</b>             | Octave 0 sets the current octave. There are 7 octaves (0 through 6). Default is 4. Middle C is at the beginning of octave 3.  |
| <b>P(n)</b>             | Pause. <b>P</b> may range from 1-64.  |

|                   |   |
|-------------------|---|
| <b>T(n)</b>       | Tempo. <b>T</b> sets the number of L4s in a minute. n may range from 32-255. Default is 120.  |
| <b>. (period)</b> | <p>A period after a note increases the playing time of the note by 3/2 times the period determined by L (length of note) times T (tempo). Multiple periods can appear after a note, and the playing time is scaled accordingly. For example, A. will cause the note A to play one and half times the playing time determined by L (length of the note) times T (the tempo); two periods placed after A (A..) will cause the note to be played at 9/4 times its ascribed value; an A with three periods (A...) at 27/8, etc.</p> <p>Periods may also appear after a P (pause), and increase the pause length as described above.</p> |
| <b>Xstring;</b>   | <p>Executes a substring, where string is a variable assigned to a string of <b>PLAY</b> commands.</p> <p>Because of the slow clock interrupt rate, some notes do not play at higher tempos; for example, 1.64 at T255. These note/tempo combinations must be determined through experimentation.</p>  |
| <b>&gt;n</b>      | A greater-than symbol preceding the note <b>n</b> plays the note in the next higher octave.   |
| <b>&lt;n</b>      | A less-than symbol preceding the note <b>n</b> plays the note in the next lower octave.   |

## Note

Numeric arguments follow the same syntax described under the **DRAW** statement.

**n** as an argument can be a constant, or it can be a variable with = in front of it (= **variable**). A semicolon is required after the variable and also after the variable in **Xstring**.

# PLAY(n) Function

## Purpose:

To return the number of notes currently in the background music queue.

## Syntax:

PLAY(*n*)

## Comments:

*n* is a dummy argument, and may be any value.

PLAY(*n*) returns 0 when in music foreground mode.

The maximum returned value of x is 32.

## Examples:

```
10   ' when 4 notes are left in
20   ' queue play another tune
30   PLAY "MBABCDABCDABCD"
40   IF PLAY (0) =4 then 200
200  PLAY "MBCDEFCDEF"
```



# PMAP Function (Graphics)

## Purpose:

To map expressions to logical or physical coordinates.

## Syntax:

*x*=PMAP (*exp*, *function*)

## Comments:

This function is valid for graphics modes only.

*x* is the physical coordinate of the point that is to be mapped.

*exp* is a numeric variable or expression.

| Function | Maps                              |
|----------|-----------------------------------|
| 0        | logical expressions to physical x |
| 1        | logical expressions to physical y |
| 2        | physical expressions to logical x |
| 3        | physical expressions to logical y |

PMAP is used with WINDOW and VIEW to translate coordinates.

# POINT Function

## Purpose:

To read the color or attribute value of a pixel from the screen.

## Syntax:

`POINT(x, y)`  
`POINT(function)`

## Comments:

In the first syntax, *x* and *y* are coordinates of the point to be examined.

If the point given is out of range, the value -1 is returned.

See the **COLOR** and **PALETTE** statements for valid color and attribute values.

**POINT** with one argument allows you to retrieve the current graphics coordinates.

**POINT(*function*)** returns the value of the current x or y graphics coordinates as follows:

| Function | Returns   |
|----------|---|
| 0        | the current physical x coordinate.  |
| 1        | the current physical y coordinate.  |
| 2        | the current logical x coordinate if <b>WINDOW</b> is active; otherwise, it returns the current physical x coordinate as in 0 above. |
| 3        | the current logical y coordinate if <b>WINDOW</b> is active; otherwise, it returns the current physical y coordinate as in 1 above. |

### Example 1:

```
10 SCREEN 1
20 FOR C=0 TO 3
30 PSET (10, 10), C
40 IF POINT(10, 10) <> C THEN PRINT "BROKEN BASIC="
50 NEXT C
RUN
```

### Example 2:

The following inverts the current state of a point:

```
10 SCREEN 2
20 IF POINT(I, I) <> 0 THEN PRESET(I, I) ELSE PSET(I, I)
RUN
```

### Example 3:

The following is another way to invert a point:

```
20 PSET (I, I), 1-POINT(I, I)
RUN
```

# POKE Statement

## Purpose:

To write (poke) a byte of data into a memory location.

## Syntax:

**POKE** *a*, *b*

## Comments:

*a* and *b* are integer expressions.

The integer expression *a* is the offset address of the memory location to be poked. The **DEF SEG** statement last executed determines the address. GW-BASIC does not check any offsets that are specified.

The integer expression *b* is the data to be poked.

*b* must be within the range of 0 to 255. *a* must be within the range of 0 to 65535.

The complementary function to **POKE** is **PEEK**. The argument to **PEEK** is an address from which a byte is to be read.

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

## Examples:

**20 POKE &H5A00, &HFF**

Places the decimal value 255 (&HFF) into the hex offset location (23040 decimal) See **PEEK** function example.

# POS Function

## Purpose:

To return the current cursor position.

## Syntax:

`POS(c)`

## Comments:

The leftmost position is 1.

*c* is a dummy argument.

## Examples:

```
10 CLS
20 WIDTH 80
30 AS=INKEYS: IF AS="" THEN GOTO 30 ELSE PRINT AS;
40 IF POS(X)>10 THEN PRINT CHR$(13);
50 GOTO 30
```

Causes a carriage return after the 10th character is printed on each line of the screen.

# PRESET and PSET Statements

## Purpose:

To display a point at a specified place on the screen during use of the graphics mode.

## Syntax:

```
PRESET(x, y) [, color]  
PSET(x, y) [, color]
```

## Comments:

(*x*, *y*) represents the coordinates of the point.

*color* is the color of the point.

Coordinates can be given in either absolute or relative form.

### Absolute Form

(*absolute x*, *absolute y*) is more common and refers directly to a point without regard to the last point referenced. For example:

```
(10, 10)
```

### Relative Form

STEP (*x offset*, *y offset*) is a point relative to the most recent point referenced. For example:

```
STEP(10, 10)
```

Coordinate values can be beyond the edge of the screen. However, values outside the integer range (-32768 to 32767) cause an "Overflow" error.

(0,0) is always the upper-left corner and (0,199) is the lower-left corner in both high resolution and medium resolution.

See the COLOR and PALETTE statements for more information.

If the value for color is greater than 3, an "Illegal function call" error is returned.

### Example 1:

The following draws a diagonal line from (0,0) to (100,100).

```
10 CLS
20 SCREEN 1
30 FOR I=0 TO 100
40 PSET (I, I)
50 NEXT
60 LOCATE 14, 1
```

### Example 2:

The following clears out the line by setting each pixel to 0.

```
40 FOR I=100 TO 0 STEP -1
50 PSET(I, I), 0
60 NEXT I
```

# PRINT Statement

## Purpose:

To output a display to the screen.

## Syntax:

```
PRINT [list of expressions][;]  
? [list of expressions][;]
```

## Comments:

If *list of expressions* is omitted, a blank line is displayed.

If *list of expressions* is included, the values of the expressions are displayed. Expressions in the list may be numeric and/or string expressions, separated by commas, spaces, or semicolons. String constants in the list must be enclosed in double quotation marks.

For more information about strings, see the **STRINGS** function.

A question mark (?) may be used in place of the word **PRINT** when using the GW-BASIC program editor.

## Print Positions

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

| Separator | Print Position               |
|-----------|------------------------------|
| ,         | Beginning of next zone       |
| ;         | Immediately after last value |
| space(s)  | Immediately after last value |

If a comma, semicolon, or **SPC** or **TAB** function ends an expression list, the next **PRINT** statement begins printing on the same line, accordingly spaced. If the expression list ends without a comma, semicolon, or **SPC** or **TAB** function, a carriage return is placed at the end of the lines (GW-BASIC places the cursor at the beginning of the next line).

A carriage return/line feed is automatically inserted after printing *width* characters, where *width* is 40 or 80, as defined in the **WIDTH** statement. This results in two lines being skipped when you print exactly 40 (or 80) characters, unless the **PRINT** statement ends in a semicolon.

When numbers are printed on the screen, the numbers are always followed by a space. Positive numbers are preceded by a space. Negative numbers are preceded by a minus (-) sign. Single-precision numbers are represented with seven or fewer digits in a fixed-point or integer format.



See the **LPRINT** and **LPRINT USING** statements for information on sending data to be printed on a printer.

**Examples:**

```
10 XS= STRING$(10, 45)
20 PRINT XS"MONTHLY REPORT" XS
-----MONTHLY REPORT-----
Ok
```

45 is the decimal equivalent of the ASCII symbol for the minus (-) sign.

# PRINT USING Statement

## Purpose:

To print strings or numbers using a specified format.

## Syntax:

**PRINT USING** *string expressions*; *list of expressions*[; ]

## Comments:

*string expressions* is a string literal or variable consisting of special formatting characters. The formatting characters determine the field and the format of printed strings or numbers.

*list of expressions* consists of the string or numeric expressions separated by semicolons.

## String Fields

The following three characters may be used to format the string field:

**!** Specifies that only the first character in the string is to be printed.

**\n spaces\** Specifies that 2+n characters from the string are to be printed.

If the backslashes are typed with no spaces, two characters are printed; if the backslashes are typed with one space, three characters are 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 is left-justified in the field and padded with spaces on the right. For example:

```
10 AS="LOOK": BS="OUT"
30 PRINT USING "!" ; AS; BS
40 PRINT USING "\  \"; AS; BS
50 PRINT USING "\  \"; AS; BS; "!!"
RUN
LO
LOOKOUT
LOOK OUT!!
```

**&** Specifies a variable length string field. When the field is specified with &, the string is output exactly as input. For example:

```
10 AS="LOOK": BS="OUT"
20 PRINT USING "!" ; AS
30 PRINT USING "&"; BS
RUN
LOUT
```

## Numeric Fields

The following special characters may be used to format the numeric field:

- # A pound 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 is 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 always is printed (as 0 if necessary). Numbers are rounded as necessary. For example:

```
PRINT USING "##. ##"; . 78
0. 78
OK
```

```
PRINT USING "###. ##"; 987. 654
987. 65
OK
```

```
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 causes 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 causes negative numbers to be printed with a trailing minus sign. For example:

```
PRINT USING "+##. ##"; - 68. 95, 2. 4, 55. 6, - 9
- 68. 95 +2. 40 +55. 60 - 0. 90
OK
```

```
PRINT USING "##. ##- "; - 68. 95, 22. 449, - 7. 01
68. 95 22. 45 7. 01-
OK
```

- \*\* 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 two more digit positions. For example:

```
PRINT USING "***. #"; 12. 39, - 0. 9, 765. 1
*12. 4* - 09765. 1
Ok
```

- \$\$ A double dollar sign at the beginning of the format string 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. For example:

```
PRINT USING "$$###. ##"; 456. 78
$456. 78
Ok
```

**\*\*\$** The **\*\*\$** at the beginning of a format string combines the effects of the above two symbols. Leading spaces are filled with asterisks, and a dollar sign is printed before the number. **\*\*\$** specifies three more digit positions, one of which is the dollar sign. For example:

```
PRINT USING "**$##. ##"; 2. 34
***$2. 34
```

**,** A comma to the left of the decimal point in the format string causes a comma to be printed to the left of every third digit to the left of the decimal point. A comma at the end of the format string is printed as part of the string.

```
PRINT USING "####. ##"; 1234. 5
1234. 50
Ok
```

**^^^^** Four carets 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 is used to the left of the decimal point to print a space or a minus sign. For example:

```
PRINT USING "##. ##^^^^"; 234. 56
2. 35E+02
Ok
```

```
PRINT USING ". ####^^^^- "; 888888
Ok
```

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

Note that in the above examples the comma is not used as a delimiter with the exponential format.

**\_** An underscore in the format string causes the next character to be output as a literal character. For example:

```
PRINT USING "_!##. ##_!"; 12. 34
!12. 34!
Ok
```

The literal character itself may be an underscore by placing "\_" in the format string.

%

A percent sign is printed in front of the number if the number to be printed is larger than the specified numeric field. If rounding causes the number to exceed the field, a percent sign is printed in front of the rounded number. For example:

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

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

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

# PRINT# and PRINT# USING Statements

## Purpose:

To write data to a sequential disk file.

## Syntax:

**PRINT#***file number*, [**USING***string expressions*; ]*list of expressions*

## Comments:

*file number* is the number used when the file was opened for output.

*string expressions* consists of the formatting characters described in the **PRINT USING** statement.

*list of expressions* consists of the numeric and/or string expressions to be written to the file.

Double quotation marks are used as delimiters for numeric and/or string expressions. The first double quotation mark opens the line for input; the second double quotation mark closes it.

If numeric or string expressions are to be printed as they are input, they must be surrounded by double quotation marks. If the double quotation marks are omitted, the value assigned to the numeric or string expression is printed. If no value has been assigned, 0 is assumed. The double quotation marks do not appear on the screen. For example:

```
10 PRINT#1, A
0
```

```
10 A=26
20 PRINT#1, A
26
```

```
10 A=26
20 PRINT#1, "A"
A
```

If double quotation marks are required within a string, use **CHR\$(34)** (the ASCII character for double quotation marks). For example:

```
100 PRINT#1, "He said, "Hello", I think"  
He said, 0, I think
```

because the machine assigns the value 0 the variable "Hello."

```
100 PRINT#1, "He said, "CHR$(34)  
"Hello, "CHR$(34) " I think."  
He said, "Hello, " I think
```

If the strings contain commas, semicolons, or significant leading blanks, surround them with double quotation marks. The following example will input "CAMERA" to A\$, and "AUTOMATIC 93604-1" to B\$:

```
10 A$="CAMERA, AUTOMATI C": B$="93604- 1"  
20 PRINT#1, A$; B$  
30 INPUT#1, A$, B$
```

To separate these strings properly, write successive double quotation marks using **CHR\$(34)**. For example:

```
40 PRINT#1, CHR$(34); A$; CHR$(34); CHR$(34); B$; CHR$(34)  
"CAMERA, AUTOMATI C" "93604- 1"
```

The **PRINT#** statement may also be used with the **USING** option to control the format of the disk file. For example:

```
PRINT#1, USING"SS###. ##. "; J; K; L
```

**PRINT#** does not compress data on the diskette. An image of the data is written to the diskette, just as it would be displayed on the terminal screen with a **PRINT** statement. For this reason, be sure to delimit the data on the diskette so that it is input correctly from the diskette.

In *list of expressions*, numeric expressions must be delimited by semicolons. For example:

```
PRINT#1, A; B; C; X; Y; Z
```

If commas are used as delimiters, the extra blanks inserted between print fields will also be written to the diskette. Commas have no effect, however, if used with the exponential format.

String expressions must be separated by semicolons in the list. To format the string expressions correctly on the diskette, use explicit delimiters in **list of expressions**. For example, the following:

```
10 A$="CAMERA": B$="93604- 1"  
20 PRINT#1, A$, B$
```

gives a diskette image of:

```
CAMERA93604- 1
```

Because there are no delimiters, this would not be input as two separate strings. To correct the problem, insert explicit delimiters into the **PRINT#** statement as follows:

```
30 PRINT#1, A$; ", "; B$
```

This gives the following diskette image, which can be read back into two string variables:

```
CAMERA, 93604- 1
```



# PUT Statement (Files)

## Purpose:

To write a record from a random buffer to a random disk file.

## Syntax:

`PUT[#] file number [, record number]`

## Comments:

*file number* is the number under which the file was opened.

*record number* is the number of the record. If it is omitted, the record has the next available record number (after the last **PUT**).

The largest possible record number is  $2^{32} - 1$ . This will allow you to have large files with short record lengths. The smallest possible record number is 1.

The **PRINT#**, **PRINT# USING**, **LSET**, **RSET**, or **WRITE#** statements may be used to put characters in the random file buffer before a **PUT** statement.

In the case of **WRITE#**, GW-BASIC pads the buffer with spaces up to an enter.

Any attempt to read or write past the end of the buffer causes a **Field overflow** error.

**PUT** can be used for communications files. Here record number is the number of bytes written to the file. Record number must be less than or equal to the length of the buffer set in the **OPEN "COM(*n*)"** statement.

# PUT Statement (Graphics)

## Purpose:

To transfer graphics images to the screen.

## Syntax:

`PUT(x, y), array, [, action verb]`

## Comments:

*action verb* may be **PSET**, **PRESET**, **AND**, **OR**, **XOR**.

The (x,y) are the coordinates of the top-left corner of the image to be transferred.

The **PUT** and **GET** statements transfer graphics images to and from the screen. **PUT** and **GET** make possible animation and high-speed object motion in either graphics mode.

The **PUT** statement transfers the image stored in the array onto the screen. The specified point is the coordinate of the upper-left corner of the image. An "Illegal function call" error results if the image to be transferred is too large to fit onto the screen.

The action verb is used to interact the transferred image with the image already on the screen. **PSET** transfers the data onto the screen verbatim.

**PRESET** is the same as **PSET** except that an inverse image (black on white) is produced.

**AND** transfers the image only if an image already exists under the transferred image.

**OR** superimposes the image onto the existing image.

**XOR** is a special mode often used for animation. **XOR** causes the points on the screen to be inverted where a point exists in the array image. This behavior is exactly like the cursor on the screen.

**XOR** is especially useful for animation. When an image is put against a complex background twice, the background is restored unchanged. An object can be moved around the screen without obliterating the background.

The default action mode is **XOR**.

For more information about effects within the different modes, see the **COLOR**, **PALETTE**, and **SCREEN** statements.

Animation of an object is usually performed as follows:

1. Put the object(s) on the screen.

2. Recalculate the new position of the object(s).
3. Put the object(s) on the screen a second time at the old location(s) to remove the old image(s).
4. Return to Step 1, this time putting the object(s) at the new location.

Movement done this way leaves the background unchanged. Flicker can be cut down by minimizing the time between Steps 4 and 1, and by making sure that there is enough time delay between Steps 1 and 3. If more than one object is being animated, process every object at once, one step at a time.

If it is not important to preserve the background, animation can be performed using the **PSET** action verb.

Leave a border around the image (when it is first gotten) as large or larger than the maximum distance the object will move. Thus, when an object is moved, this border effectively erases any points. This method may be somewhat faster than the method using **XOR** described above since only one **PUT** is required to move an object. However, the image to be **PUT** must be larger than the existing image.

### Examples:

```
10 CLS: SCREEN 1
20 PSET (130, 120)
30 DRAW "U25; E7; R20; D32; L6; U12; L14"
40 DRAW "D12; L6": PSET(137, 102)
50 DRAW "U4; E4; R8; D8; L12"
60 PSET (137, 88)
70 DRAW "E4; R20; D32; G4": PAINT (131, 119)
80 DIM A (500)
90 GET (125, 130) - (170, 80), A
100 FOR I= 1 TO 1000: NEXT I
110 PUT (20, 20), A, PSET
120 FOR I= 1 TO 1000: NEXT i
130 GET (125, 130) - (170, 80), A
140 FOR I= 1 TO 1000: NEXT I
150 PUT (220, 130), A, PRESET
```

# RANDOMIZE Statement

## Purpose:

To reseed the random number generator.

## Syntax:

```
RANDOMIZE [expression]  
RANDOMIZE TIMER
```

## Comments:

If expression is omitted, GW-BASIC suspends program execution and asks for a value by displaying the following line:

```
Random number seed (-32768 to 32767)?
```

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

To change the sequence of random numbers every time the program is run, place a **RANDOMIZE** statement at the beginning of the program, and change the argument with each run (see **RND** function).

**RANDOMIZE** with no arguments will prompt you for a new seed. **RANDOMIZE [*expression*]** will not force floating-point values to integer. *expression* may be any numeric formula.

To get a new random seed without prompting, use the new numeric **TIMER** function as follows:

```
RANDOMIZE TIMER
```

### Example 1:

The internal clock can be set at intervals.

```
10 RANDOMIZE TIMER
20 FOR I=1 to 5
30 PRINT RND;
40 NEXT I
RUN
.88598 .484668 .586328 .119426 .709225
Ok

RUN
.803506 .162462 .929364 .292443 .322921
Ok
```

### Example 2:

The internal clock can be used for random number seed.

```
5 N=VAL(MID$(TIMES, 7, 2)) 'get seconds for seed
10 RANDOMIZE N 'install number
20 PRINT N 'print seconds
30 PRINT RND 'print random number generated
RUN
36
.2466638
Ok
RUN
37
.6530511
Ok
RUN
38
5.943847E+02
Ok
RUN
40
.8722131
Ok
```

# READ Statement

## Purpose:

To read values from a **DATA** statement and assign them to variables.

## Syntax:

**READ** *list of variables*

## Comments:

A **READ** statement must always be used with a **DATA** statement.

**READ** statements assign variables to **DATA** statement values on a one-to-one basis.

**READ** statement variables may be numeric or string, and the values read must agree with the variable types specified. If they do not agree, a "**Syntax error**" results.

A single **READ** statement may access one or more **DATA** statements. They are accessed in order. Several **READ** statements may access the same **DATA** statement.

If the number of variables in *list of variables* exceeds the number of elements in the **DATA** statement(s), an "**Out of data**" message is printed.

If the number of variables specified is fewer than the number of elements in the **DATA** statement(s), subsequent **READ** statements 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.

## Examples:

```
. . .  
80 FOR I=1 TO 10  
90 READ A(I)  
100 NEXT I  
110 DATA 3.08, 5.19, 3.12, 3.98, 4.24  
120 DATA 5.08, 5.55, 4.00, 3.16, 3.37  
. . .
```

This program segment reads the values from the **DATA** statements into array A. After execution, the value of A(1) is 3.08, and so on. The **DATA** statement (lines 110-120) may be placed anywhere in the program; they may even be placed ahead of the **READ** statement.

```
5 PRINT  
10 PRINT "CITY", "STATE", "ZIP"  
20 READ C$, S$, Z  
30 DATA "DENVER, ", "COLORADO", 80211  
40 PRINT C$, S$, Z  
RUN
```

```
CITY STATE ZIP  
DENVER, COLORADO 80211  
Ok
```

This program reads string and numeric data from the **DATA** statement in line 30.

# REM Statement

## Purpose:

To allow explanatory remarks to be inserted in a program.

## Syntax:

```
REM[ comment ]  
' [ comment ]
```

## Comments:

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

Once a **REM** or its abbreviation, an apostrophe ( ' ), is encountered, the program ignores everything else until the next line number or program end is encountered.

**REM** statements may be branched into from a **GOTO** or **GOSUB** statement, and execution continues with the first executable statement after the **REM** statement. However, the program runs faster if the branch is made to the first statement.

Remarks may be added to the end of a line by preceding the remark with an apostrophe ( ' ) instead of **REM**.

## Note

Do not use **REM** in a **DATA** statement because it will be considered to be legal data.

## Examples:

```
. . .  
120 REM CALCULATE AVERAGE VELOCITY  
130 FOR I=1 TO 20  
440 SUM=SUM+V(I)  
450 NEXT I
```

or

```
129 FOR I=1 TO 20 ' CALCULATED AVERAGE VELOCITY  
130 SUM=SUM+V(I)  
140 NEXT I
```



# RENUM Command

## Purpose:

To renumber program lines.

## Syntax:

**RENUM**[ *new number* ], [ *old number* ] [ , *increment* ]

## Comments:

*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 is 10.

**RENUM** also changes all line number references following **ELSE**, **GOTO**, **GOSUB**, **THEN**, **ON. . . GOTO**, **ON. . . GOSUB**, **RESTORE**, **RESUME**, 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 x iny**" appears. The incorrect line number reference **x** is not changed by **RENUM**, but line number **y** may be changed.

**RENUM** cannot be used to change the order of program lines (for example, **RENUM 15, 30** when the program has three lines numbered 10, 20 and 30) or to create line numbers greater than 65529. An "**Illegal function call**" error results.

## Examples:

### **RENUM**

Renumbers the entire program. The first new line number will be 10. Lines increment by 10.

### **RENUM 300, , 50**

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

### **RENUM 1000, 900, 20**

Renumbers the lines from 900 up so they start with line number 1000 and are incremented by 20.

# RESET Command

## Purpose:

To close all disk files and write the directory information to a diskette before it is removed from a disk drive.

## Syntax:

**RESET**

## Comments:

Always execute a **RESET** command before removing a diskette from a disk drive. Otherwise, when the diskette is used again, it will not have the current directory information written on the directory track.

**RESET** closes all open files on all drives and writes the directory track to every diskette with open files.

# RESTORE Statement

## Purpose:

To allow **DATA** statements to be reread from a specified line.

## Syntax:

**RESTORE**[*line number*]

## Comments:

If line number is specified, the next **READ** statement accesses the first item in the specified **DATA** statement.

If line number is omitted, the next **READ** statement accesses the first item in the first **DATA** statement.

## Examples:

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

Assigns the value 57 to both A and D variables, 68 to B and E, and so on.

# RESUME Statement

## Purpose:

To continue program execution after an error-recovery procedure has been performed.

## Syntax:

```
RESUME  
RESUME 0  
RESUME NEXT  
RESUME line number
```

## Comments:

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

| Syntax                           | Result   |
|----------------------------------|--|
| <b>RESUME</b> or <b>RESUME 0</b> | Execution resumes at the statement that caused an error.                               |
| <b>RESUME NEXT</b>               | Execution resumes at the statement immediately following the one that caused an error. |
| <b>RESUME <i>line number</i></b> | Execution resumes at the specified line number.  |

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

## Examples:

```
10 ON ERROR GOTO 900
```

```
900 IF (ERR=230)AND(ERL=90) THEN PRINT "TRY AGAIN": RESUME 80
```

If an error occurs after line 10 is executed, the action indicated in line 900 is taken and the program continues at line 80.

# RETURN Statement

## Purpose:

To return from a subroutine.

## Syntax:

**RETURN** [*line number*]

## Comments:

The **RETURN** statement causes GW-BASIC to branch back to the statement following the most recent **GOSUB** statement. A subroutine may contain more than one **RETURN** statement to return from different points in the subroutine. Subroutines may appear anywhere in the program.

**RETURN line number** is primarily intended for use with event trapping. It sends the event-trapping routine back into the GW-BASIC program at a fixed line number while still eliminating the **GOSUB** entry that the trap created.

When a trap is made for a particular event, the trap automatically causes a **STOP** on that event so that recursive traps can never take place. The **RETURN** from the trap routine automatically does an **ON** unless an explicit **OFF** has been performed inside the trap routine.

The nonlocal **RETURN** must be used with care. Any **GOSUB**, **WHILE**, or **FOR** statement active at the time of the trap remains active.

# RIGHT\$ Function

## Purpose:

To return the rightmost *i* characters of string *x\$*.

## Syntax:

**RIGHT\$(*x\$, i*)**

## Comments:

If *i* is equal to or greater than **LEN(*x\$*)**, **RIGHT\$** returns *x\$*. If *i* equals zero, the null string (length zero) is returned (see the **MID\$** and **LEFT\$** functions).

## Examples:

```
10 A$="DISK BASIC"  
20 PRINT RIGHT$(A$, 5)  
RUN  
BASIC  
Ok
```

Prints the rightmost five characters in the A\$ string.

# RMDIR Command

## Purpose:

To delete a subdirectory.

## Syntax:

**RMDIR** *pathname*

## Comments:

*pathname* is a string expression, not exceeding 63 characters, identifying the subdirectory to be removed from its parent.

The subdirectory to be deleted must be empty of all files except ". " and ". ." or a "Path file/access error" is given.

## Examples:

Referring to the sample directory structure illustrated in **CHDIR**, the following command deletes the subdirectory report:

**RMDIR "SALES\JOHN\REPORT"**

# RND Function

## Purpose:

To return a random number between 0 and 1.

## Syntax:

**RND[ (x) ]**

## Comments:

The same sequence of random numbers is generated each time the program is run unless the random number generator is reseeded (see **RANDOMIZE** statement). If x is equal to zero, then the last number is repeated.

If x is greater than 0, or if **x** is omitted, the next random number in the sequence is generated.

To get a random number within the range of zero through **n**, use the following formula:

**INT(RND\*(n+1))**

The random number generator may be seeded by using a negative value for **x**.

## Examples:

```
10 FOR I=1 TO 5
20 PRINT INT(RND*101);
30 NEXT
RUN
 53 30 31 51 5
Ok
```

Generates five pseudo-random numbers within the range of 0-100.

# RUN Command

## Purpose:

To execute the program currently in memory, or to load a file from the diskette into memory and run it.

## Syntax:

```
RUN [line number][, r]  
RUN filename[, r]
```

## Comments:

**RUN** or **RUN *line number*** runs the program currently in memory.

If ***line number*** is specified, execution begins on that line. Otherwise, execution begins at the lower line number.

If there is no program in memory when **RUN** is executed, GW-BASIC returns to command level.

**RUN *filename*** closes all open files and deletes the current memory contents before loading the specified file from disk into memory and executing it.

The **r** option keeps all data files open.

If you are using the speaker on the computer, please note that executing the **RUN** command will turn off any sound that is currently running and will reset to Music Foreground. Also, the **PEN** and **STRIG** Statements are reset to **OFF**.

## Examples:

```
RUN "NEWFIL", R
```

Runs *NEWFIL.BAS* without closing data files.



# SAVE Command

## Purpose:

To save a program file on diskette.

## Syntax:

SAVE *filename*, [, a]

SAVE *filename*, [, p]

## Comments:

*filename* is a quoted string that follows the normal MS-DOS naming conventions. If *filename* already exists, the file will be written over. If the extension is omitted, .bas will be used.

The **a** option saves the file in ASCII format. Otherwise, GW-BASIC saves the file in a compressed binary format. ASCII format takes more space on the diskette, but some diskette access commands (for example, the **MERGE** command and some MS-DOS commands, such as TYPE) may require an ASCII format file.

The **p** option protects 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 fails. When the **p** option is used, make an additional copy under another name or diskette to facilitate future program maintenance.

## Examples:

The following command saves the file com2.bas in the ASCII format:

```
SAVE "COM2", A
```

The following command saves the file prog.bas in binary format, and protects access:

```
SAVE "PROG", P
```

# SCREEN Function

## Purpose:

To return the ASCII code (0-255) for the character at the specified row (line) and column on the screen.

## Syntax:

`x=SCREEN(row, col [, z])`

## Comments:

`x` is a numeric variable receiving the ASCII code returned.

`row` is a valid numeric expression within the range 1 to 25.

`col` is a valid numeric expression 1 to 40, or 1 to 80, depending upon screen width setting. See the **WIDTH** statement.

`z` is a valid numeric expression with a true or false value. It may be used only in alpha mode.

The ordinal of the character at the specified coordinates is stored in the numeric variable. In alpha mode, if the optional parameter `z` is given and is true (nonzero), the color attribute for the character is returned instead of the ASCII code for the character (see the **COLOR** statement).

Any values entered outside of the range indicated result in an "Illegal function call" error. Row 25 may be referenced only if the function key is off.

## Examples:

`100 X=SCREEN (10, 10)`

If the character at 10,10 is A, then X is 65.

`110 X= SCREEN (1, 1, 1)`

Returns the color attribute of the character in the upper-left corner of the screen.

# SCREEN Statement

## Purpose:

To set the specifications for the display screen.

## Syntax:

`SCREEN [mode] [, [colorswitch]] [, [apage]] [, [vpage]]`

## Comments:

The **SCREEN** statement is chiefly used to select a screen mode appropriate for a particular display-hardware configuration. Supported hardware configurations and screen modes are described below.

### MDPA with Monochrome Display: Mode 0

The IBM Monochrome Display and Printer Adapter (MDPA) is used to connect only to a monochrome display. Programs written for this configuration must be text mode only.

### CGA with Color Display: Modes 0, 1, and 2

The IBM Color Graphics Adapter (CGA) and Color Display are typically paired with each other. This hardware configuration permits the running of text mode programs, and both medium-resolution and high-resolution graphics programs.

### EGA with Color Display: Modes 0, 1, 2, 7, and 8

The five screen modes 0, 1, 2, 7, and 8 allow you to interface to the IBM Color Display when it is connected to an IBM Enhanced Graphics Adapter (EGA). If EGA switches are set for CGA compatibility, programs written for modes 1 and 2 will run just as they would with the CGA. Modes 7 and 8 are similar to modes 1 and 2, except that a wider range of colors is available in modes 7 and 8.

### EGA with Enhanced Color Display: Modes 0, 1, 2, 7, and 8

With the EGA/IBM Enhanced Display configuration, modes 0, 1, 2, 7, and 8 are virtually identical to their EGA/Color Display counterparts. Two possible differences are as follows:

1. In mode 0, the border color cannot be the same as for the EGA/Color Display because the border cannot be set on an Enhanced Color Display when it is in 640 x 350 text mode.
2. The quality of the text is better on the Enhanced Color Display (an 8 x 14 character box for Enhanced Color Display versus an 8 x 8 character box for color display).

## **EGA with Enhanced Color Display: Mode 9**

The full capability of the Enhanced Color Display is taken advantage of in this mode. Mode 9 allows the highest resolution possible for the EGA/Enhanced Color Display configuration. Programs written for this mode will not work for any other hardware configuration.

## **EGA with Monochrome Display: Mode 10**

The IBM Monochrome Display can be used to display monochrome graphics at a very high resolution in this mode. Programs written for this mode will not work for any other hardware configuration.

## **Arguments**

The mode argument is an integer expression with legal values 0, 1, 2, 7, 8, 9 and 10. All other values are illegal. Selection of a mode argument depends primarily on your program's anticipated display hardware, as described above.

Each of the **SCREEN** modes is described individually in the following paragraphs.

### **SCREEN 0**

- o Text mode only
- o Either 40 x 25 or 80 x 25 text format with character-box size of 8 x 8 (8 x 14 with EGA)
- o Assignment of 16 colors to any of 2 attributes
- o Assignment of 16 colors to any of 16 attributes (with EGA)

### **SCREEN 1**

- o 320 x 200 pixel medium-resolution graphics
- o 80 x 25 text format with character-box size of 8 x 8
- o Assignment of 16 colors to any of 4 attributes
- o Supports both EGA and CGA
- o 2 bits per pixel

## SCREEN 2

- o 640 x 200 pixel high-resolution graphics
- o 40 x 25 text format with character-box size of 8 x 8
- o Assignment of 16 colors to any of 2 attributes
- o Supports both EGA and CGA
- o 1 bit per pixel

## SCREEN 7

- o 320 x 200 pixel medium-resolution graphics
- o 40 x 25 text format with character-box size of 8 x 8
- o 2, 4, or 8 memory pages with 64K, 128K, or 256K of memory, respectively, installed on the EGA
- o Assignment of any of 16 colors to 16 attributes
- o EGA required
- o 4 bit per pixel

## SCREEN 8

- o 640 x 200 pixel high-resolution graphics
- o 80 x 25 text format with character-box size of 8 x 8
- o 1, 2, or 4 memory pages with 64K, 128K, or 256K of memory, respectively, installed on the EGA
- o Assignment of any of 16 colors to 16 attributes
- o EGA required
- o 4 bits per pixel

## SCREEN 9

- o 640 x 350 pixel enhanced-resolution graphics
- o 80x25 text format with character-box size of 8 x 14
- o Assignment of either 64 colors to 16 attributes (more than 64K of EGA memory), or 16 colors to 4 attributes (64K of EGA memory)
- o Two display pages if 256K of EGA memory installed
- o EGA required
- o 2 bits per pixel (64K EGA memory)  
4 bits per pixel (more than 64K EGA memory)

## SCREEN 10

- o 640 x 350 enhanced-resolution graphics
- o 80 x 25 text format with character-box size of 8 x 14
- o Two display pages if 256K of EGA memory installed
- o Assignment of up to 9 pseudo-colors to 4 attributes
- o EGA required
- o 2 bits per pixel

The following are default attributes for **SCREEN 10**, monochrome display:

| Attribute Value | Displayed Pseudo-Color |
|-----------------|------------------------|
| 0               | Off                    |
| 1               | On, normal intensity   |
| 2               | Blink                  |
| 3               | On, high intensity     |

The following are color values for **SCREEN 10**, monochrome display:

| Color Value | Displayed Pseudo-Color       |
|-------------|------------------------------|
| 0           | Off                          |
| 1           | Blink, off to on             |
| 2           | Blink, off to high intensity |
| 3           | Blink, on to off             |
| 4           | On                           |
| 5           | Blink, on to high intensity  |
| 6           | Blink, high intensity to off |
| 7           | Blink, high intensity to on  |
| 8           | High intensity               |

For both composite monitors and TVs, the *colorswitch* is a numeric expression that is either true (non-zero) or false (zero). A value of zero disables color and permits display of black and white images only. A nonzero value permits color. The meaning of the *colorswitch* argument is inverted in **SCREEN** mode 0.

For hardware configurations that include an EGA and enough memory to support multiple-screen pages, two arguments are available. These *apage* and *vpag*e arguments determine the "active" and "visual" memory pages. The active page is the area in memory where graphics statements are written; the visual page is the area of memory that is displayed on the screen.

Animation can be achieved by alternating the display of graphics pages. The goal is to display the visual page with completed graphics output, while executing graphics statements in one or more active pages. A page is displayed only when graphics output to that page is complete. Thus, the following program fragment is typical:

```
SCREEN 7, , 1, 2 'work in page 1, show page 2
.
. Graphics output to page 1
. while viewing page 2
.
SCREEN 7, , 2, 1 'work in page 2, show page 1
.
. Graphics output to page 2
. while viewing page 1
.
```

The number of pages available depends on the **SCREEN** mode and the amount of available memory, as described in the following table:

**Table 2 - SCREEN Mode Specifications**

| Mode | Resolution     | Attribute Range  | Color Range       | EGA Memory | Pages | Page Size |
|------|----------------|------------------|-------------------|------------|-------|-----------|
| 0    | 40-column text | NA               | 0-15 <sup>a</sup> | NA         | 1     | 2K        |
|      | 80-column text | NA               | 0-15 <sup>a</sup> | NA         | 1     | 4K        |
| 1    | 320 x 200      | 0-3 <sup>b</sup> | 0-3               | NA         | 1     | 16K       |
| 2    | 640 x 200      | 0-1 <sup>b</sup> | 0-1               | NA         | 1     | 16K       |
| 7    | 320 x 200      | 0-15             | 0-15              | 64K        | 2     | 32K       |
|      |                |                  |                   | 128K       | 4     |           |
|      |                |                  |                   | 256K       | 8     |           |
| 8    | 640 x 200      | 0-15             | 0-15              | 64K        | 1     | 64K       |
|      |                |                  |                   | 128K       | 2     |           |
|      |                |                  |                   | 256K       | 4     |           |
| 9    | 640 x 350      | 0-3              | 0-15              | 64K        | 1     | 64K       |
|      |                | 0-15             | 0-63              | 128K       | 1     | 128K      |
|      |                | 0-15             | 0-63              | 256K       | 2     |           |
| 10   | 640 x 350      | 0-3              | 0-8               | 128K       | 1     | 128K      |
|      |                |                  |                   | 256K       | 2     |           |

<sup>a</sup> Numbers in the range 16-31 are blinking versions of the colors 0-15.

<sup>b</sup> Attributes applicable only with EGA.

### Attributes and Colors

For various screen modes and display hardware configurations, different attribute and color settings exist. (See the **PALETTE** statement for a discussion of attribute and color number.) The majority of these attribute and color configurations are summarized in the following table:



**Table 3 - Default Attributes and Colors for Most Screen Modes**

| Attributes for Mode |    |                      | Color Display       |                      | Monochrome          | Display                     |
|---------------------|----|----------------------|---------------------|----------------------|---------------------|-----------------------------|
| 1,9                 | 2  | 0,7,8,9 <sup>b</sup> | Number <sup>c</sup> | Color                | Number <sup>c</sup> | Color                       |
| 0                   | 0  | 0                    | 0                   | Black                | 0                   | Off                         |
|                     | 1  |                      | 1                   | Blue                 |                     | (Underlined) <sup>a</sup>   |
|                     | 2  |                      | 2                   | Green                | 1                   | On <sup>a</sup>             |
|                     | 3  |                      | 3                   | Cyan                 | 1                   | On <sup>a</sup>             |
|                     | 4  |                      | 4                   | Red                  | 1                   | On <sup>a</sup>             |
|                     | 5  |                      | 5                   | Magenta              | 1                   | On <sup>a</sup>             |
|                     | 6  |                      | 6                   | Brown                | 1                   | On <sup>a</sup>             |
|                     | 7  |                      | 7                   | White                | 1                   | On <sup>a</sup>             |
|                     | 8  |                      | 8                   | Gray                 | 0                   | Off                         |
|                     | 9  |                      | 9                   | Light Blue           |                     | High intensity (underlined) |
|                     | 10 |                      | 10                  | Light Green          | 2                   | High intensity              |
| 1                   |    | 11                   | 11                  | Light Cyan           | 2                   | High intensity              |
|                     | 12 |                      | 12                  | Light Red            | 2                   | High intensity              |
| 2                   |    | 13                   | 13                  | Light Magenta        | 2                   | High intensity              |
|                     | 14 |                      | 14                  | Yellow               | 2                   | High intensity              |
| 3                   | 1  | 15                   | 15                  | High-intensity White | 0                   | Off                         |

<sup>a</sup> Off when used for background.

<sup>b</sup> With EGA memory > 64K.

<sup>c</sup> Only for mode 0 monochrome.

The default foreground colors for the various modes are given in the following table:

**Table 4 - Default Foreground Colors**

| Screen Mode | Default foreground attribute        |                    | Default foreground color            |                    |
|-------------|-------------------------------------|--------------------|-------------------------------------|--------------------|
|             | Color/Extended Display <sup>a</sup> | Monochrome Display | Color/Extended Display <sup>a</sup> | Monochrome Display |
| 0           | 7                                   | 7                  | 7                                   | 1                  |
| 1           | 3                                   | NA                 | 15                                  | NA                 |
| 2           | 1                                   | NA                 | 15                                  | NA                 |
| 7           | 15                                  | NA                 | 15                                  | NA                 |
| 8           | 15                                  | NA                 | 15                                  | NA                 |
| 9           | 3 <sup>b</sup>                      | NA                 | 63                                  | NA                 |
| 10          | NA                                  | 3                  | NA                                  | 8                  |

<sup>a</sup> IBM Enhanced Color Display

<sup>b</sup> 15 if greater than 64K of EGA memory

NA=Not Applicable

# SGN Function

## Purpose:

To return the sign of **x**.

## Syntax:

**SGN(x)**

## Comments:

**x** is any numeric expression.

If **x** is positive, **SGN(x)** returns 1.

If **x** is 0, **SGN(x)** returns 0.

If **x** is negative, **SGN(x)** returns -1.

This statement is similar to, but not the same as **SIN(x)**, which returns a trigonometric function in radians, rather than in ones and zeros.

## Examples:

```
10 INPUT "Enter value", x
20 ON SGN(X)+2 GOTO 100, 200, 300
```

GW-BASIC branches to 100 if X is negative, 200 if X is 0, and 300 if X is positive.

# SHELL Statement

## Purpose:

To load and execute another program or batch file. When the program finishes, control returns to the GW-BASIC program at the statement following the **SHELL** statement. A program executed under control of GW-BASIC is referred to as a child process.

## Syntax:

**SHELL** [*string*]

## Comments:

*string* is a valid string expression containing the name of a program to run and (optionally) command arguments.

The program name in string may have any extension that MS-DOS COMMAND.COM supports. If no extension is supplied, COMMAND will look for a .COM file, then an .EXE file, and finally, a .BAT file. If none is found, **SHELL** will issue a "**File not found**" error.

Any text separated from the program name by at least one blank space will be processed by COMMAND as program parameters. GW-BASIC remains in memory while the child process is running. When the child process finishes, GW-BASIC continues at the statement following the **SHELL** statement.

**SHELL** with no string will go to MS-DOS. You may now do anything that COMMAND allows. When ready to return to GW-BASIC, type the MS-DOS command EXIT.

## Examples:

```
SHELL  
A>DIR  
A>EXIT  
Ok
```

Write some data to be sorted, use **SHELL SORT** to sort it, then read the sorted data to write a report.

```
10 OPEN "SORTIN.DAT" FOR OUTPUT AS #1  
20 'write data to be sorted  
. . .  
1000 CLOSE 1  
1010 SHELL "SORT <SORTIN.DAT >SORTOUT.DAT"  
1020 OPEN "SORTOUT.DAT" FOR INPUT AS #1  
1030 'Process the sorted data
```

# SIN Function

## Purpose:

To calculate the trigonometric sine of  $x$ , in radians.

## Syntax:

$\text{SIN}(x)$

## Comments:

$\text{SIN}(x)$  is calculated in single-precision unless the `/d` switch is used when GW-BASIC is executed.

To obtain  $\text{SIN}(x)$  when  $x$  is in degrees, use  $\text{SIN}(x * \pi / 180)$ .

## Examples:

```
PRINT SIN(1.5)
.9974951
Ok
```

The sine of 1.5 radians is .9974951 (single-precision).

# SOUND Statement

## Purpose:

To generate sound through the speaker.

## Syntax:

**SOUND** *freq, duration*

## Comments:

*freq* is the desired frequency in Hertz (cycles per second). *freq* is a numeric expression within the range of 37 to 32767.

*duration* is the desired duration in clock ticks. Clock ticks occur 18.2 times per second. *duration* must be a numeric expression within the range of 0 to 65535.

Values below .022 produce an infinite sound until the next **SOUND** or **PLAY** statement is executed.

If *duration* is zero, any active **SOUND** statement is turned off. If no **SOUND** statement is running, a duration of zero has no effect.

The sound is executed in foreground or background depending on the **PLAY** statement.

## Examples:

The following example creates random sounds of short duration:

```
2500 SOUND RND*1000+37, 2
2600 GOTO 2500
```

The following table shows the relationship of notes and their frequencies in the two octaves adjacent to middle C.

**Table 5 - Relationships of Notes and Frequencies**

| Note | Frequency | Note | Frequency |
|------|-----------|------|-----------|
| C    | 130.810   | C*   | 523.250   |
| D    | 146.830   | D    | 587.330   |
| E    | 164.810   | E    | 659.260   |
| F    | 174.610   | F    | 698.460   |
| G    | 196.000   | G    | 783.990   |
| A    | 220.000   | A    | 880.000   |
| B    | 246.940   | B    | 987.770   |
| C    | 261.630   | C    | 1046.500  |
| D    | 293.660   | D    | 1174.700  |
| E    | 329.630   | E    | 1318.500  |
| F    | 349.230   | F    | 1396.900  |
| G    | 392.000   | G    | 1568.000  |
| A    | 440.000   | A    | 1760.000  |
| B    | 493.880   | B    | 1975.500  |

\*Middle C.

By doubling or halving the frequency, the coinciding note values can be estimated for the preceding and following octaves.

To produce periods of silence, use the following statement:

**SOUND 32767, duration**

To calculate the duration of one beat, divide beats per minute into the number of clock ticks in a minute (1092).

The following table illustrates tempos requested by clock ticks:

**Table 6 - Tempos Requested by Clock Ticks**

| Tempo     | Beats/<br>Notation | Ticks/<br>Minute | Beat        |
|-----------|--------------------|------------------|-------------|
| very slow | Larghissimo        |                  |             |
|           | Largo              | 40-66            | 27.3-18.2   |
|           | Laghetto           | 60-66            | 18.2-16.55  |
|           | Grave              |                  |             |
|           | Lento              |                  |             |
|           | Adagio             | 66-76            | 16.55-14.37 |
| slow      | Adagietto          |                  |             |
|           | Andante            | 76-108           | 14.37-10.11 |
| medium    | Andantino          |                  |             |
|           | Moderato           | 108-120          | 10.11-9.1   |
| fast      | Allegretto         |                  |             |
|           | Allegro            | 120-168          | 9.1-6.5     |
|           | Vivace             |                  |             |
|           | Veloce             |                  |             |
|           | Presto             | 168-208          | 6.5-5.25    |
| very fast | Prestissimo        |                  |             |

# SPACE\$ Function

## Purpose:

To return a string of x spaces.

## Syntax:

SPACE\$(*x*)

## Comments:

*x* is rounded to an integer and must be within the range of 0 to 255 (see [SPC](#) function).

## Examples:

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

Line 20 adds one space for each loop execution.



# SPC Function

## Purpose:

To skip a specified number of spaces in a **PRINT** or an **LPRI NT** statement.

## Syntax:

**SPC(*n*)**

## Comments:

*n* must be within the range of 0 to 255.

If *n* is greater than the defined width of the printer or the screen, the value used will be *n MOD* width.

A semicolon is assumed to follow the **SPC(*n*)** command.

**SPC** may only be used with **PRINT**, **LPRI NT** and **PRINT#** statements (see the **SPACES** function).

## Examples:

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

# SQR Function

## Purpose:

Returns the square root of  $x$ .

## Syntax:

$SQR(x)$

## Comments:

$x$  must be greater than or equal to 0.

$SQR(x)$  is computed in single-precision unless the `/d` switch is used when GW-BASIC is executed.

## Examples:

```
10 FOR X=10 TO 25 STEP 5
20 PRINT X; SQR(X)
30 NEXT
RUN
10 3.162278
15 3.872984
20 4.472136
25 5
Ok
```

# STICK Function

## Purpose:

To return the x and y coordinates of two joysticks.

## Syntax:

$x = \text{STICK}(n)$

## Comments:

$x$  is a numeric variable for storing the result.

$n$  is a valid numeric expression within the range of 0 to 3.

| Value of $n$ | Coordinate Returned  |
|--------------|--|
| 0            | x coordinate of joystick A. Stores the x and y values for both joysticks for the following three function calls. |
| 1            | y coordinate of joystick A.  |
| 2            | x coordinate of joystick B.  |
| 3            | y coordinate of joystick B.  |

# STOP Statement

## Purpose:

To terminate program execution and return to command level.

## Syntax:

**STOP**

## Comments:

**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 files.

GW-BASIC always returns to command level after a **STOP** is executed. Execution is resumed by issuing a **CONT** command.

## Examples:

```
10 INPUT A, B, C
20 K=A^2*5. 3: L=B^3/. 26
30 STOP
40 M=C*K+100: PRINT M
RUN
? 1, 2, 3
BREAK IN 30
Ok
PRINT L
30. 76923
Ok
CONT
115. 9
Ok
```

# STR\$ Function

## Purpose:

To return a string representation of the value of **x**.

## Syntax:

**STR\$(x)**

## Comments:

**STR\$(x)** is the complementary function to **VAL(x\$)** (see the **VAL** function).

## Examples:

```
5 REM ARITHMETIC FOR KIDS
10 INPUT "TYPE A NUMBER"; N
20 ON LEN(STR$(N)) GOSUB 30, 40, 50
. . .
```

This program branches to various subroutines, depending on the number of characters typed before the RETURN key is pressed.

# STRIG Statement and Function

## Purpose:

To return the status of the joystick triggers.

## Syntax:

As a statement:

STRIG ON  
STRIG OFF

As a function:

**x**=STRIG(**n**)

## Comments:

**x** is a numeric variable for storing the result.

**n** is a valid numeric expression within the range of 0 to 7.

**STRIG ON** must be executed before any **STRIG(n)** function calls may be made. Once **STRIG ON** is executed, GW-BASIC will check to see if a button has been pressed before every statement is executed. **STRIG OFF** disables the checking.

**n** is a numeric expression within the range of 0 to 7 that returns the following values:

| Value of <b>n</b> | Returns  |
|-------------------|--|
| 0 -1              | if trigger A1 was pressed since the last <b>STRIG(0)</b> statement; returns 0, if not. |
| 1 -1              | if trigger A1 is currently pressed; returns 0, if not.                                 |
| 2 -1              | if trigger B1 was pressed since the last <b>STRIG(2)</b> statement; returns 0, if not. |
| 3 -1              | if trigger B1 is currently pressed; returns 0, if not.                                 |
| 4 -1              | if trigger A2 was pressed since the last <b>STRIG(4)</b> statement; returns 0 if not.  |
| 5 -1              | if trigger A2 is currently pressed; returns 0, if not.                                 |

# STRIG(n) Statement

## Purpose:

To allow the use of a joystick by enabling or disabling the trapping of its buttons.

## Syntax:

STRIG(*n*) ON  
STRIG(*n*) OFF  
STRIG(*n*) STOP

## Comments:

*n* is 0, 2, 4, or 6, corresponding to the buttons on the joystick, where

0 is button A1  
2 is button B1  
4 is button A2  
6 is button B2

## Examples:

STRIG(*n*) ON

Enables trapping of the joystick buttons. After this statement is executed, GW-BASIC checks to see if this button has been pressed before executing following statements.

STRIG(*n*) OFF

Disables GW-BASIC from checking the state of the button.

STRIG(*n*) STOP

Disables trapping of a given button through the **ON STRIG(*n*)** statement. But, any pressings are remembered so that trapping may take place once it is reenabled.

# STRING\$ Function

## Purpose:

To return

- o a string of length *n* whose characters all have ASCII code *j*, or
- o the first character of *x\$*

## Syntax:

STRING\$(*n*, *j*)  
STRING\$(*n*, *x\$*)

## Comments:

STRING\$ is also useful for printing top and bottom borders on the screen or the printer.

*n* and *j* are integer expressions in the range 0 to 255.

## Examples:

```
10 X$ = STRING$(10, 45)
20 PRINT X$ "MONTHLY REPORT" X$
RUN
-----MONTHLY REPORT-----
Ok
```

45 is the decimal equivalent of the ASCII symbol for the minus (-) sign.

Appendix C in the GW-BASIC User's Guide lists ASCII character codes.



# SWAP Statement

## Purpose:

To exchange the values of two variables.

## Syntax:

*SWAP variable1, variable2*

## Comments:

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.

## Examples:

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

Line 30 swaps the values in the A\$ and B\$ strings.

# SYSTEM Command

## Purpose:

To return to MS-DOS.

## Syntax:

**SYSTEM**

## Comments:

Save your program before pressing RETURN, or the program will be lost.

The **SYSTEM** command closes all the files before it returns to MS-DOS. If you entered GW-BASIC through a batch file from MS-DOS, the **SYSTEM** command returns you to the batch file, which continues executing at the point it left off.

## Examples:

**SYSTEM**

A>

# TAB Function

## Purpose:

Spaces to position *n* on the screen.

## Syntax:

TAB(*n*)

## Comments:

If the current print position is already beyond space *n*, TAB goes to that position on the next line.

Space 1 is the leftmost position. The rightmost position is the screen width.

*n* must be within the range of 1 to 255.

If the TAB function is at the end of a list of data items, GW-BASIC will not return the cursor to the next line. It is as though the TAB function has an implied semicolon after it.

TAB may be used only in PRINT, LPRINT, or PRINT# statements (see the SPC function).

## Examples:

```
10 PRINT "NAME" TAB(25) "AMOUNT": PRINT
20 READ A$, BS
30 PRINT A$ TAB(25) BS
40 DATA "G. T. JONES", "$25.00"
RUN
NAME AMOUNT

G. T. JONES $25.00
Ok
```

# TAN Function

## Purpose:

To calculate the trigonometric tangent of **x**, in radians.

## Syntax:

**TAN(x)**

## Comments:

**TAN(x)** is calculated in single-precision unless the **/d** switch is used when GW-BASIC is executed.

If **TAN** overflows, the "Overflow" error message is displayed; machine infinity with the appropriate sign is supplied as the result, and execution continues.

To obtain **TAN(x)** when **x** is in degrees, use **TAN(x\*pi/180)**.

## Examples:

**10 Y = TAN(X)**

When executed, Y will contain the value of the tangent of X radians.

# TIME\$ Statement and Variable

## Purpose:

To set or retrieve the current time.

## Syntax:

As a statement:

**TIME\$ = *string exp***

As a variable:

***string exp* = TIME\$**

## Comments:

***string exp*** is a valid string literal or variable that lets you set hours (***hh***), hours and minutes (***hh: mm***), or hours, minutes, and seconds (***hh: mm: ss***).

***hh*** sets the hour (0-23). Minutes and seconds default to 00.

***hh: mm*** sets the hour and minutes (0-59). Seconds default to 00.

***hh: mm: ss*** sets the hour, minutes, and seconds (0-59).

If ***string exp*** is not a valid string, a **"Type mismatch"** error results.

As you enter any of the above values, you may omit the leading zero, if any. You must, however, enter at least one digit. If you wanted to set the time as a half hour after midnight, you could enter **TIME\$= "0: 30"**, but not **TIME\$= ": 30"**.

If any of the values are out of range, an **"Illegal function call"** error is issued. The previous time is retained.

The current time is stored if **TIME\$** is the target of a string assignment.

The current time is fetched and assigned to the string variable if **TIME\$** is the expression in a **LET** or **PRINT** statement.

If ***string exp* = TIME\$**, **TIME\$** returns an 8-character string in the form ***hh: mm: ss***.

## Examples:

The following example sets the time at 8:00 A.M.:

```
TIMES = "08: 00"  
Ok  
PRINT TIMES  
08: 00: 05  
Ok
```

The following program displays the current date and time on the 25th line of the screen and will sound on the minute and half minute.

```
10 KEY OFF: SCREEN 0: WIDTH 80: CLS  
20 LOCATE 25, 5  
30 PRINT DATES, TIMES;  
40 SEC=VAL(MID$(TIMES, 7, 2))  
50 IF SEC=SSEC THEN 20 ELSE SSEC=SEC  
60 IF SEC=0 THEN 1010  
70 IF SEC=30 THEN 1020  
80 IF SEC<57 THEN 20  
  
1000 SOUND 1000, 2: GOTO 20  
1010 SOUND 2000, 8: GOTO 20  
1020 SOUND 400, 4: GOTO 20
```

## TIMER Function

### Purpose:

To return single-precision floating-point numbers representing the elapsed number of seconds since midnight or system reset.

### Syntax:

`v=TIMER`

### Comments:

Fractions of seconds are calculated to the nearest degree possible. Timer is read-only.

# TRON/TROFF Commands

## Purpose:

To trace the execution of program statements.

## Syntax:

TRON  
TROFF

## Comments:

As an aid in debugging, the **TRON** (trace on) command enables a trace flag that prints each line number of the program as it is executed. The numbers appear enclosed in square brackets.

**TRON** may be executed in either the direct or indirect mode.

The trace flag is disabled with the **TROFF** (trace off) command, or when a **NEW** command is executed.

## Examples:

```
TRON
Ok
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
RUN
[10][20][30][40] 1 10 20
[50][60][30][40] 2 20 30
[50][60][70]
Ok
TROFF
Ok
```

# UNLOCK Statement

## Purpose:

To release locks that have been applied to an opened file. This is used in a multi-device environment, often referred to as a network or network environment.

## Syntax:

```
UNLOCK [#]n [, [record number] [TO record number]]
```

## Comments

*n* is the number that was assigned the file as it was originally numbered in the program.

*record number* is the number of the individual record that is to be unlocked. Or, if a range of records are to be unlocked, *record number* designates the beginning and ending record of the specified range.

The range of legal record numbers is 1 to 2<sup>32</sup> -1. The limit on record size is 32767 bytes.

The record range specified must be from lower to (the same or) higher record numbers.

If a starting record number is not specified, the record number 1 is assumed.

If an ending record number is not specified, then only the specified record is unlocked.

The following are legal **UNLOCK** statements:

**UNLOCK #*n*** unlocks the entire file *n*

**UNLOCK #*n*, *X*** unlocks record *X* only

**UNLOCK #*n*, TO *Y*** unlocks records 1 through *Y*

**UNLOCK #*n*, *X* TO *Y*** unlocks records *X* through *Y*

The locked file or record range should be unlocked before the file is closed.

Failure to execute the **UNLOCK** statement can jeopardize future access to that file in a network environment.

In the case of files opened in random mode, if a range of record numbers is specified, this range must match exactly the record number range given in the **LOCK** statement.

The "**Permission denied**" message will appear if a syntactically correct **UNLOCK** request cannot be granted. The **UNLOCK** statement must match exactly the paired **LOCK** statement.



It is expected that the time in which files or regions within files are locked will be short, and thus the suggested usage of the **LOCK** statement is within shortterm paired **LOCK/UNLOCK** statements.

### Examples:

The following demonstrates how the **LOCK/UNLOCK** statements should be used:

```
LOCK #1, 1 TO 4  
LOCK #1, 5 TO 8  
UNLOCK #1, 1 TO 4  
UNLOCK #1, 5 TO 8
```

The following example is illegal:

```
LOCK #1, 1 TO 4  
LOCK #1, 5 TO 8  
UNLOCK #1, 1 TO 8
```

# USR Function

## Purpose:

To call an assembly language subroutine.

## Syntax:

**v=USR[ *n* ] ( *argument* )**

## Comments:

**n** specifies which **USR** routine is being called.

argument can be any numeric or string expression.

Although the **CALL** statement is recommended for calling assembly language subroutines, the **USR** function call may also be used. See Appendix D in the GW-BASIC User's Guide for a comparison of **CALL** and **USR** and for a detailed discussion of calling assembly language subroutines.

Only values 0-9 are valid for n. If n is omitted, **USRO** is assumed (see **DEF USR** for the rules governing n).

If a segment other than the default segment (GW-BASIC data segment, DS) is used, a **DEF SEG** statement must be executed prior to a **USR** call. This ensures that the code segment points to the subroutine being called.

The segment address given in the **DEF SEG** statement determines the starting segment of the subroutine.

For each **USR** function, a corresponding **DEF USR** statement must have been executed to define the **USR** call offset. This offset and the currently active **DEF SEG** segment address determine the starting address of the subroutine.

If more than 10 user routines are required, the value(s) of **DEF USR** may be redefined for the other starting addresses as many times as needed.

The type (numeric or string) of the variable receiving the function call must be consistent with the argument passed. If no argument is required by the assembly language routine, then a dummy argument must be supplied.

# VAL Function

## Purpose:

Returns the numerical value of string **x\$**.

## Syntax:

**VAL(x\$)**

## Comments:

The **VAL** function also strips leading blanks, tabs, and line feeds from the argument string. For example, the following line returns -3:

**VAL(" - 3")**

The **STR\$** function (for numeric to string conversion) is the complement to the **VAL(x\$)** function.

If the first character of **x\$** is not numeric, the **VAL(x\$)** will return zero.

## Examples:

```
10 READ NAME$, CITY$, STATES$, ZIP$
20 IF VAL(ZIP$)<90000 OR VAL(ZIP$)>96699 THEN
PRINT NAME$ TAB(25) "OUT OF STATE"
30 IF VAL(ZIP$)>=90801 AND VAL(ZIP$)<=90815 THEN
PRINT NAME$ TAB(25) "LONG BEACH"
```

# VARPTR Function

## Purpose:

To return the address in memory of the variable or file control block (FCB).

## Syntax:

**VARPTR**(*variable name*)

**VARPTR**(*#file number*)

## Comments:

**VARPTR** is usually used to obtain the address of a variable or array so it can be passed to an assembly language subroutine. A function call of the following form:

**VARPTR**(A(0))

is usually specified when passing an array, so that the lowest-addressed element of the array is returned.

All simple variables should be assigned before calling **VARPTR** for an array, because the addresses of the arrays change whenever a new simple variable is assigned.

**VARPTR** (*#file number*) returns the starting address of the GW-BASIC File Control Block assigned to *file number*.

**VARPTR** (*variable name*) returns the address of the first byte of data identified with the variable name.

A value must be assigned to variable name prior to execution of **VARPTR**, otherwise, an "Illegal function call" error results.

Any type variable name may be used (numeric, string, or array), and the address returned will be an integer within the range of 32767 to -32768. If a negative address is returned, it is added to 65536 to obtain the actual address.

Offsets to information in the FCB from the address returned by **VARPTR** are shown in the following table:

**Table 7 - Offsets to FCB Information**

| Offset | Length   | Name   | Description   |
|--------|--|--------|---|
| 0      | 1<br>1<br>2<br>4<br>16<br>32<br>64<br>128                        | Mode   | The mode in which the file was opened:<br>Input only<br>Output only<br>Random I/O<br>Append only<br>Internal use<br>Future use<br>Internal use                        |
| 1      | 38   | FCB    | Diskette file control block.  |
| 39     | 2  | CURLOC | Number of sectors read or written for sequential access. The last record number +1 read or written for random files.  |
| 41     | 1  | ORNOFS | Number of bytes in sector when read or written.   |
| 42     | 1  | NMLOFS | Number of bytes left in <b>INPUT</b> buffer.  |
| 43     | 3  | ***    | Reserved for future expansion.  |
| 46     | 1<br>0-9<br>255<br>254<br>253<br>252<br>251<br>250<br>249<br>248 | DEVICE | Device Number:<br>Disks A: through J:<br><b>KYBD:</b><br><b>SCRN:</b><br><b>LPT1:</b><br><b>CAS1:</b><br><b>COM1:</b><br><b>COM2:</b><br><b>LPT2:</b><br><b>LPT3:</b> |
| 47     | 1  | WIDTH  | Device width.   |
| 48     | 1  | POS    | Position in buffer for <b>PRINT</b> .   |
| 49     | 1  | FLAGS  | Internal use during <b>BLOAD/BSAVE</b> .<br>Not used for data files.  |
| 50     | 1  | OUTPOS | Output position used during tab expansion.  |
| 51     | 128  | BUFFER | Physical data buffer. Used to transfer data between DOS and BASIC. Use  |

this offset to examine data in sequential I/O mode.

|     |          |        |  |
|-----|----------|--------|--|
| 179 | 2<br>128 | VRECL  | Variable length record size. Default is Set by length option in OPEN statement.  |
| 181 | 2        | PHYREC | Current physical record number.  |
| 183 | 2        | LOGREC | Current logical record number.   |
| 185 | 1        | ***    | Future use.  |
| 186 | 2        | OUTPOS | Disk files only. Output position for <b>PRINT</b> , <b>INPUT</b> , and <b>WRITE</b> .  |
| 188 | n        | FIELD  | Actual FIELD data buffer. Size is determined by S:switch. VRECL bytes are transferred between BUFFER and FIELD on I/O operations. Use this offset to examine file data in random I/O mode. |

### Example 1:

**100 X=VARPTR(Y)**

When executed, the variable X will contain an address that points to the storage space assigned to the variable Y.

### Example 2:

```
10 OPEN "DATA. FIL" AS #1  
20 FCBADR = VARPTR(#1)  
30 DATADR = FCBADR+188  
40 A$ = PEEK(DATADR)
```

In line 20, FCBADR contains the start of FCB.

In line 30, DATADR contains the address of the data buffer.

In line 40, A\$ contains the first byte in the data buffer.

# VARPTR\$ Function

## Purpose:

To return a character form of the offset of a variable in memory.

## Syntax:

**VARPTR\$(*variable*)**

## Comments:

*variable* is the name of a variable that exists in the program.

## Note

Assign all simple variables before calling **VARPTR\$** for an array element, because the array addresses change when a new simple variable is assigned.

**VARPTR\$** returns a three-byte string of the following form:

| Byte 0 | Byte 1 | Byte 2 |

Byte 0 contains one of the following variable types:

- 2      integer
- 3      string
- 4      single-precision
- 8      double precision

Byte 1 contains the 8086 address format, and is the least significant byte.  
Byte 2 contains the 8086 address format, and is the most significant byte.

## Examples:

**100 X = USR(VARPTR\$(Y))**

# VIEW Statement

## Purpose:

To define a physical viewport limit from **x1,y1** (upper-left x,y coordinates) to **x2,y2** (lower-right x,y coordinates).

## Syntax:

```
VIEW [[SCREEN] [(x1, y1) - (x2, y2) [, [fill] [, [border]]]]]
```

## Comments:

**RUN** or **VIEW** with no arguments define the entire screen as the viewport.

**(x1, y1)** are the upper-left coordinates.

**(x2, y2)** are the lower-right coordinates.

The **fill** attribute lets you fill the view area with color.

The **border** attribute lets you draw a line surrounding the viewport if space for a border is available. If border is omitted, no **border** is drawn.

The **x** and **y** coordinates must be within the physical bounds of the screen and define the rectangle within the screen that graphics map into. The **x** and **y** coordinate pairs will be sorted, with the smallest values placed first.

Points are plotted relative to the viewpoint if the screen argument is omitted; that is, **x1** and **y1** are added to the **x** and **y** coordinates before the point is plotted.

It is possible to have a varied number of pairs of x and y. The only restriction is that **x1** cannot equal **x2**, and **y1** cannot equal **y2**.

Points are plotted absolutely if the **SCREEN** argument is present. Only points within the current viewport will be plotted.

When using **VIEW**, the **CLS** statement clears only the current viewport. To clear the entire screen, you must use **VIEW** to disable the viewports. Then use **CLS** to clear the screen. **CLS** does not move the cursor to home. Press CTRL-HOME to send the cursor home, and clear the screen.



## Examples:

The following defines a viewport such that the statement **PSET(0, 0), 3** would set down a point at the physical screen location 10,10.

**VIEW (10, 10) - (200, 100)**

The following defines a viewport such that the point designated by the statement **PSET(0, 0), 3** would not appear because 0,0 is outside of the viewport. **PSET(10, 10), 3** would be within the viewport.

**VIEW SCREEN (10, 10) - (200, 100)**

## VIEW PRINT Statement

### Purpose:

To set the boundaries of the screen text window.

### Syntax:

**VIEW PRINT** [*topline* TO *bottomline*]

### Comments:

**VIEW PRINT** without *topline* and *bottomline* parameters initializes the whole screen area as the text window. The whole screen area consists of lines 1 to 24; by default, line 25 is not used.

Statements and functions that operate within the defined text window include **CLS**, **LOCATE**, **PRINT**, and **SCREEN**.

The screen editor will limit functions such as scroll and cursor movement to the text window.

For more information, see **VIEW**.

# WAIT Statement

## Purpose:

To suspend program execution while monitoring the status of a machine input port.

## Syntax:

`WAIT port number, n[,j]`

## Comments:

`port number` represents a valid machine port number within the range of 0 to 65535.

`n` and `j` are integer expressions in the range of 0 to 255.

The **WAIT** statement causes execution to be suspended until a specified machine input port develops a specified bit pattern.

The data read at the port is **XOR**ed with the integer expression `j`, and then **AND**ed with `n`.

If the result is zero, GW-BASIC loops back and reads the data at the port again. If the result is nonzero, execution continues with the next statement.

When executed, the **WAIT** statement tests the byte `n` for set bits. If any of the bits is set, then the program continues with the next statement in the program. **WAIT** does not wait for an entire pattern of bits to appear, but only for one of them to occur.

It is possible to enter an infinite loop with the **WAIT** statement. You can exit the loop by pressing CTRL-BREAK, or by resetting the system.

If `j` is omitted, zero is assumed.

## Examples:

`100 WAIT 32, 2`

Suspends machine operation until port 32 receives 2 as input.

# WHILE-WEND Statement

## Purpose:

To execute a series of statements in a loop as long as a given condition is true.

## Syntax:

```
WHILE expression  
.  
[loop statements]  
.  
WEND
```

## Comments:

If *expression* is nonzero (true), *loop statements* are executed until the **WEND** statement is encountered. GW-BASIC then returns to the **WHILE** statement and checks expression. If it is still true, the process is repeated.

If it is not true, execution resumes with the statement following the **WEND** statement.

**WHILE** and **WEND** loops may be nested to any level. Each **WEND** matches the most recent **WHILE**.

An unmatched **WHILE** statement causes a "**WHILE without WEND**" error. An unmatched **WEND** statement causes a "**WEND without WHILE**" error.

## Examples:

```
90 ' BUBBLE SORT ARRAY A$  
100 FLIPS=1  
110 WHILE FLIPS  
115 FLIPS=0  
120 FOR N=1 TO J-1  
130 IF A$(N)>A$(N+1) THEN SWAP A$(N), A$(N+1): FLIPS=1  
140 NEXT N  
150 WEND
```

# WIDTH Statement

## Purpose:

To set the printed line width in number of characters for the screen and line printer.

## Syntax:

```
WIDTH size  
WIDTH file number, size  
WIDTH "dev", size
```

## Comments:

*size*, an integer within the range of 0 to 255, is the new width.

*file number* is the number of the file that is open.

*dev* is a valid string expression identifying the device. Valid devices are **SCRN:** , **LPT1:** , **LPT2:** , **LPT3:** , **COM1:** , and **COM2:** .

## Changing Screen Width

The following statements are used to set the screen width. Only a 40- or 80-column width is allowed.

```
WIDTH size  
WIDTH "SCRN: ", size
```

See the **SCREEN** statement for more information.

Changing **SCREEN** mode affects screen width only when moving between **SCREEN 2** and **SCREEN 1** or **SCREEN 0**.

## Note

Changing the screen width clears the screen and sets the border screen color to black.

## Changing Lineprinter Width

The following **WIDTH** statement is used as a deferred width assignment for the lineprinter. This statement stores the new width value without actually changing the current width setting:

```
WIDTH "LPT1: ", size
```

A statement of the following form recognizes this stored width value:

```
OPEN "LPT1: " FOR OUTPUT AS number
```

and uses it while the file is open:

```
WIDTH file number, size
```

If the file is open to **lpt1:**, lineprinter width is immediately changed to the new size specified. This allows the width to be changed at will while the file is open. This form of **WIDTH** has meaning only for **lpt1:**. After outputting the indicated number of characters from the open file, GW-BASIC inserts a carriage return at the end of the line and wraps the output, if the width is less than the length of the record.

Valid widths for the line printer are 1 through 255.

Specifying **WIDTH 255** for the line printer (**lpt1:**) enables line wrapping. This has the effect of infinite width.

Any value entered outside of these ranges results in an **"Illegal function call"** error. The previous value is retained.

Using the **WIDTH** statement on a communications file causes a carriage return to be sent after the number of characters specified by the size attribute. It does not alter either the receive or transmit buffer.

### Examples:

```
10 WIDTH "LPT1: ", 75  
20 OPEN "LPT1: " FOR OUTPUT AS #1
```

```
6020 WIDTH #1, 40
```

Line 10 stores a line printer width of 75 characters per line.

Line 20 opens file #1 to the line printer and sets the width to 75 for subsequent **PRINT #1**, statements.

Line 6020 changes the current line printer width to 40 characters per line.

# WINDOW Statement

## Purpose:

To draw lines, graphics, and objects in space not bounded by the physical limits of the screen.

## Syntax:

`WI NDOW[ [ SCREEN] (x1, y1) - (x2, y2) ]`

## Comments:

`(x1, y1)` , `(x2, y2)` are the coordinates defined by the user. These coordinates, called the world coordinates, may be any single-precision, floating-point number. They define the world coordinate space that graphics statements map into the physical coordinate space, as defined by the `VIEW` statement.

`WI NDOW` is the rectangular region in the world coordinate space. It allows zoom and pan. It allows the user to draw lines, graphics, and objects in space not bounded by the physical limits of the screen. To do this the user specifies the world coordinate pairs `(x1, y1)` and `(x2, y2)` . GW-BASIC then converts the world coordinate pairs into the appropriate physical coordinate pairs for subsequent display within screen space.

Window inverts, with the screen attribute omitted, the y coordinate on subsequent graphics statements. This places the `(x1, y1)` coordinate in the lower-left and the `(x1, y2)` coordinate in the upper-right of the screen. This allows the screen to be viewed in true Cartesian coordinates.

The coordinates are not inverted when the `SCREEN` attribute is included. This places the `(x1, y1)` coordinate in the upper-left and the `(x2, y2)` coordinate in the lower-right corner of the screen.

The **WINDOW** statement sorts the x and y argument pairs into ascending order.  
For example:

**WINDOW (50, 50) - (10, 10)**

becomes

**WINDOW (10, 10) - (50, 50)**

Or

**WINDOW (- 2, 2) - (2, - 2)**

becomes

**WINDOW (- 2, - 2) - (2, 2)**

All coordinate pairs of **x** and **y** are valid, except that **x1** cannot equal **x2** and **y1** cannot equal **y2**.

**WINDOW** with no arguments disables previous window statements.

### Example 1:

If you type the following:

**NEW  
SCREEN 2**

the screen uses the standard coordinate attributes as follows:

|               |           |           |
|---------------|-----------|-----------|
| (0,0)         | (320,0)   | (639,0)   |
| ? y increases | (320,100) |           |
| (0,199)       | (320,199) | (639,199) |

### Example 2:

If you type the following:

**WINDOW (- 1, - 1) - (1, 1)**

the screen uses the Cartesian coordinates as defined in the following statement:

|               |       |       |
|---------------|-------|-------|
| (-1,1)        | (0,1) | (1,1) |
| ? y increases |       |       |
|               | (0,0) |       |
| ? y decreases |       |       |
| (-1,1)        | (0,1) | (1,1) |

### Example 3:

If you type the following:

**WINDOW SCREEN (- 1, - 1) - (1, 1)**

the screen uses the non-inverted coordinate as defined in the following statement:

|               |        |        |
|---------------|--------|--------|
| (-1,-1)       | (0,-1) | (1,-1) |
| ? y decreases |        |        |
|               | (0,0)  |        |
| ? y increases |        |        |
| (-1,1)        | (0,1)  | (1,1)  |

**RUN**, **SCREEN**, and **WINDOW** with no attributes disable any **WINDOW** definitions and return the screen to its normal physical coordinates.



# WRITE Statement

## Purpose:

To output data to the screen.

## Syntax:

**WRITE**[*list of expressions*]

## Comments:

If *list of expressions* is omitted, a blank line is output. If list of expressions is included, the values of the expressions are output at the terminal. The expressions in the list may be numeric and/or string expressions, and must be separated by commas or semicolons.

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

The difference between **WRITE** and **PRINT** is that **WRITE** inserts commas between displayed items and delimits strings with double quotation marks. Positive numbers are not preceded by blank spaces.

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

## Examples:

```
10 A=80: B=90: CS="THAT' S ALL"  
20 WRITE A, B, CS  
RUN  
80, 90, "THAT' S ALL"  
Ok
```

# WRITE# Statement

## Purpose:

To write data to a sequential file.

## Syntax:

**WRITE** *#filename list of expressions*

## Comments:

*filename* is the number under which the file was opened for output.

*list of expressions* is a list of string and/or numeric expressions separated by commas or semicolons.

The **WRITE#** and **PRINT#** statements differ in that **WRITE#** inserts commas between the items as they are written and delimits strings with quotation marks, making explicit delimiters in the list unnecessary. Another difference is that **WRITE#** does not put a blank in front of a positive number. After the last item in the list is written, a carriage return/line feed sequence is inserted.

## Examples:

Let A\$ = "CAMERA" and B\$ = "93604-1". The following statement:

**WRITE#1, A\$, B\$**

writes the following image to disk:

**"CAMERA", "93604- 1"**

A subsequent **INPUTS** statement, such as the following, would input "CAMERA" to A\$ and "93604-1" to B\$:

**INPUT#1, A\$, B\$**