ZBASIC™

Interactive BASIC Compiler

by
Andrew R. Gariepy,
Scott Terry, David Overton,
Greg Branche and Halbert Liang

Documentation by
Michael A. Gariepy

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In addition, you may contact us on the **Genie Information Service** by sending electronic mail (EM AIL) to: ZBASIC. We check our mailbox semi-regularly and will respond to you via electronic mail. We also have topics set up on the various Round-Table Bulletin Boards for general information.

Notes on the Fourth Edition

This edition of the Zbasic ™ manual contains all the computer appendices. This includes the appendix for MS-DOS™, APPLE™ //e, //c (DOS 3.3 and ProDOS), MACINTOSH™, CP/M™, and TRS-80™ Model 1, 3 and TRS-80 Model 4.

The appendices are at the back of the manual and the new index includes entries for both the reference section and the appendices. It is important to study the appendix for the computer you are using since there are usually enhancements and variations that are important to note.

Acknowledgements

Special thanks to John Kemeny and Thomas Kurtz for creating BASIC, the easiest and most powerful of all the general purpose languages. To Joanne Gariepy for many late hours of editing. An extra special thanks to the programming teams that have meant so much to the success of the product. Scott Terry, Dave Overton , Greg Branche and Hal Liang and to Thomas Dimitri and David Cooper for their help with the MSDOS version. Special thanks to Karen Moesh and Leyla Blisard for making sure Zbasic gets mailed as fast as it does and to Apple Computer, Inc. for the Macintosh™, Laserwriter™, MacDraw, and MacPaint graphic software and to Microsoft for Word™; on which this entire manual was composed and printed (both text and graphics).

Many thanks to the multitudes of Zbasic™ users who provided helpful suggestions for this fourth edition.

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ZEDCOR, INC.
4500 East Speedway Blvd. Suite 22
Tucson, Arizona 85712-5305
(602) 795-3996
(602) 881-8101
Orders: 800- 482-4567

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The reference section contains a complete alphabetical list of all Standard ZBasic commands, statements, functions and operators with cross reference to other commands and sections of the manual.

Also see the appropriate appendix for special commands or enhancements for a particular computer model.

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Computer Appendices

VERSION NOTES

Throughout this manual are notes to different versions of ZBasic.
An Icon representing the various computer type is used.

Remember the icon for your computer type. If you see the icon in the standard reference manual, a note will follow it describing something of importance for that version.

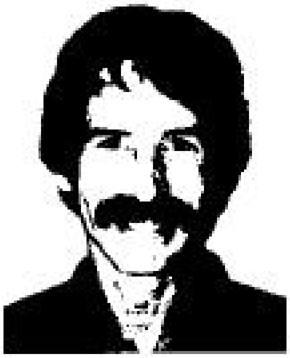
MSDOS

Z80

Apple DOS 3.3
Apple ProDOS

Macintosh

INTRODUCTION



As the original developer of ZBasic and the head of the programming team I want to thank you for your support.

I've been involved in writing Zbasic for eight years now and am very proud of what we've accomplished. It hasn't been easy but it's sure been fun. How many times does a complex product like ZBasic ever make it to market?

Over the years I have received thousands of suggestions from programmers. I've tried to implement as many of these suggestions as I could. I still need your feedback and comments so I can make ZBasic the most powerful programming tool available. Send your suggestions to the "ZBasic Wish-List Department" or to my attention.

Special thanks to my wife Janis for putting up with my programming late into the night and to the many ZBasic users that have taken the time to send letters of encouragement.

Andrew R. Gariepy
April, 1997

INTRODUCTION

ZBasic has come a long way since it was introduced in 1985. Many thousands of copies, on many different computers, have been distributed all over the planet.

We have accomplished what we set out out to do; to provide a powerful, fast, interactive, simple-to-use, inexpensive BASIC compiler that works the same way on many different computers so you only have to learn a language once.

I've worked hard to make the manual simple to follow and easy to understand.

I highly recommend that you subscribe to the ZBasic newsletter; "Z". It covers all sorts of topics about ZBasic and has listings for public domain ZBasic subroutines on diskette you can get cheap. It's jammed with hints and tricks from other ZBasic users all over the world and from the ZBasic programmers themselves. Call 800-482-4567 to order.

Thank you for your support of ZBasic. Please let us know if you have any ideas of how to improve the product.

Michael A. Gariepy
April, 1987

GETTING STARTED

GETTING STARTED

GETTING STARTED

ZBasic is provided on a diskette for your computer. Before loading ZBasic do the following:

1. Read, sign and return the License agreement in the front of this manual. Keep track of your serial number, you may need it for support.

2. Read the Appendix for your computer. It will explain any variations or enhancements for your version of ZBasic and also has important information about hardware requirements or limitations.

3. MAKE A BACKUP COPY OF THE ORIGINAL ZBasic DISKETTE. *Never use the original diskette*. If you do not know how to make backups, refer to your DOS or User Manual.

4. Using the BACKUP, load ZBasic according to the instructions for your computer below:

MS-DOS	From A>:	`ZBASIC`
CP/M-80	From A>:	`ZBASIC`
TRS-80	From `DOS READY`:	`ZBASIC`
Apple DOS 3.3	From FP prompt:	`BRUN ZBASIC`
Apple ProDOS	From FP prompt:	`-/ZBASIC/ZBASIC.SYSTEM`
Macintosh	Using the mouse:	*Double Click* ZBasic Icon

HOW TO BE A ZBASIC EXPERT IN TEN MINUTES OR LESS

The following is a quick-and-dirty course that teaches you how to TYPE, RUN, SAVE, QUIT and LOAD a program using ZBasic.

First LOAD ZBasic according to the instructions for your computer above or in your computer appendix. Some versions require that you press <E> to enter the editor. If a prompt appears asking for input, press <E>. See CONFIGURE for more information about the options being offered.

Macintosh users note that the following lessons are done in the COMMAND window.

GETTING STARTED

LESSON ONE: TYPING IN A SIMPLE PROGRAM

When you see the message; **ZBasic Ready**, you may begin entering programs. So we may demonstrate the simplicity of ZBasic, please type in the following program exactly as shown. Always type COMMANDS in UPPERCASE and remember to press <ENTER> or <RETURN> at the end of each line.

```
10 FOR Count = 1 to 10
20 PRINT "Hi, I’m ZBasic!---"
30 NEXT Count
```

Congratulations, you’ve just entered your first ZBasic program. To see a listing of the program type: `LIST`<ENTER>. To find out more about entering and editing programs, see: STANDARD LINE EDITOR. Also see your computer appendix for information about using a full screen editor (if your version has one).

LESSON TWO: RUNNING THE PROGRAM

To run the program you just entered type:

```
RUN
```

The program will print the message; `Hi, I’m ZBasic!---` ten times. ZBasic actually compiles the program but does it so fast that you’ll barely notice. When the program is finished you’re back in the editor. That’s the beauty of interactive compiling.

LESSON THREE: SAVING THE PROGRAM

To save your program, make sure you have an unprotected diskette in the drive and type:

```
SAVE MYPROG
```

The program will be saved to disk for future use.

LESSON FOUR: EXITING ZBASIC

To exit ZBasic type:

```
QUIT
```

You will now be back in the operating system. It’s a good idea to save your programs before doing this.

LESSON FIVE: HOW TO LOAD EXISTING PROGRAMS

To load the previously saved program, first re-load ZBasic then type:

```
LOAD MYPROG
```

The program you saved is now back in memory. To see it, type LIST:

```
10 FOR Count = 1 to 10
20   PRINT "Hi, I’m ZBasic!---"
30 NEXT Count
```

GETTING STARTED

A NOTE TO EXPERIENCED BASIC PROGRAMMERS:

Since the ZBasic Compiler is very similar to the BASIC interpreters found on most microcomputers (except for graphic commands and file I/O), use the Reference Section and your Computer Appendix to check syntax differences from other BASIC's. Use the Index to find more in-depth answers. The appendices in the back of this manual contain the commands and enhancements for specific computers. These appendices are also very useful for converting programs from one machine to another.

If you have been frustrated with incredibly slow interpreters and awkward, complicated compilers, you will be pleased with the power and ease of ZBasic.

A NOTE TO INEXPERIENCED BASIC PROGRAMMERS

This manual is not intended to teach you BASIC programming from scratch. If you lack programming experience we suggest picking up some of the BASIC tutorials for the IBM PC, CP/M systems or the TRS-80, available from most major bookstores and libraries. Once you learn the beginning concepts of BASIC programming, like GOSUB, FOR/NEXT and that type of thing, this manual should be all you need.

ZBasic is very similar to the IBM PC, TRS-80, MSBASIC and GW BASIC interpreters; however, most Graphic commands and Random File commands are different (sequential file commands are very similar).

For those with some experience, this section and the section "Standard Line Editor" are written in a tutorial format.

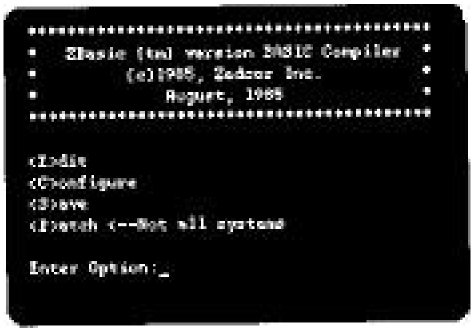
Be sure to examine the appendix in the back of this manual for your computer. It will tell you about any differences and enhancements that are important to know before you start.

CONFIGURATION

CONFIGURATION

CONFIGURATION OPTIONS

Since no two programmers are alike, we allow you to configure your version of ZBasic. Most versions start with a screen something like this:



```
******************************************
*   ZBasic (tm) version ZBASIC Compiler  *
*          (c)1985, Zedcor Inc.          *
*              August, 1985              *
******************************************

<E>dit
<C>onfigure
<S>ave
<P>atch <--Not all systems

Enter Option:_
```

As you can see below, configuring your version of ZBasic is simple. Simply set the parameters the way you want, then save the reconfigured ZBasic:

<E>dit

Type "E" to enter the Standard Line Editor. Once in the editor, you may LOAD, TYPE, RUN, EDIT, SAVE or DEBUG your programs.

<C>onfigure

Typing "C" allows you to configure certain parts of ZBasic. Note that in most cases you will not have to change parameters. See next page for options.

<S>ave

Typing "S" allows you to save ZBasic with the configuration defaults set to your options. This way you don’t have to reconfigure ZBasic every time you load it.

<P>atch

Type "P" allows you to make patches to ZBasic. If we make minor changes you won’t have to return you disk to us for an upgrade. Not available on all versions.

CONFIGURATION

CHANGING CONFIGURATION

It is simple to change configurations. If the default value is not to your liking simply type in the value you want. Press <ENTER> to skip inputs, Press <BREAK> or <CNTR C> to go back to the main menu.

STANDARD CONFIGURE QUESTIONS			HEX	Decimal	INPUT
1.	Double Precision Accuracy	6-54	000E	00014	?_
2.	Single Precision Accuracy	2-52	0006	00006	?_
3.	Scientific Precision 2-Double Prec.		0006	00006	?_
4.	Maximum File Buffers Open	0 - 99	0002	00002	?_
5.	Array Base	0 or 1	0000	00000	?_
6.	Rounding Number	0 - 99	0031	00049	?_
7.	Default Variable Type: <S>ingle, <D>ouble, <I>nteger			I	?_
8.	Test Array Bounds <Y/N>			N	?_
9.	Convert to uppercase <Y/N>			N	?_
10.	*Optimize expressions as Integer? Y/N			Y	?_
11.	*Space required after Keywords? Y/N			N	?_

* Not all versions.

DEFINITIONS OF THE STANDARD CONFIGURE QUESTIONS

1. Set from six to 54 digits of precision for Double Precision math. Defaults to 14.
2. Set from four up to two digits less than Double precision. Defaults to 6.
3. Digits of math precision for Scientific functions (ATN, COS etc.)
4. Set the number of files you want OPEN at one time. Up to 99. Two is the default.
5. Array Base 0 or 1. Set zero or one as ARRAY start. Zero is default.
6. Rounding Factor. Sets rounding for PRINT USING and other things.
7. Set variable default to Integer, Single or Double precision.
   Press I, S or D key. Same as DEFDBL, DEFSNG, DEFINT A-Z.
8. Check the runtime program (object code) for array values going out of DIM bounds.
   (Slows the program down but is very good for debugging purposes)
9. Tells ZBasic to convert all lowercase entries to UPPERCASE.
   The variable "FRED" is the same as the variable "Fred" if this is done.
10. Two ways to evaluate expressions. Integer or Floating Point.
    Defaults to integer for speed and size. Set to NO if you want defaults as real.
11. Forcing a space after keywords allows you to embed keywords in variables.

IMPORTANT NOTE: If you change configuration, make sure all CHAINED programs have EXACTLY THE SAME CONFIGURATION. Otherwise unpredictable results may occur.

Macintosh: Select the "Configure" menu item to change or save configuration options. **MSDOS** and **ProDOS** versions of ZBasic have a CONFIG command that allows resetting the options from the Standard line editor. ***CP/M, Apple DOS 3.3** and **TRS-80** versions may not have the last two options offered. Check the appropriate appendix for specifics.

STANDARD LINE EDITOR

STANDARD EDITOR

ZBasic comes with a Standard Editor that works the same way on all computers. While most versions of ZBasic now come with a full screen editor which is easier and faster to use, the Standard Editor allows you to do quick-and-dirty editing and direct commands like an interpreter.

Learning the Standard Editor will allow you to jump from one version of ZBasic to another without having to re-learn the full screen editor for that particular machine.

ENTERING THE EDITOR

Load ZBasic. When the screen says: **ZBasic Ready** you have entered the ZBasic Interactive Programming Environment (a fancy name for the Standard Editor) and may enter programs and type direct commands.

The Standard Line Editor requires each line of a program to have a line number for editing and reference purposes (labels are available too.) Line numbers may range from 0-65534. Each line can be up to 250 characters long. To add a line, type a line number and the text, or use the AUTO command to have ZBasic assign line numbers automatically (some versions of ZBasic will allow you to enter programs without using line numbers. Check your appendix). If you are loading a program without line numbers, they will be added automatically. Line numbers are used for editing in the Standard Line Editor only.

Important Note: Always type keywords and commands in uppercase. Select "Convert to Uppercase" under Configure if you don’t want to worry about it.

Important Note: This entire section deals with commands that are to be executed from the Standard Line Editor. If you are in the full screen editor you will need to switch to the Standard Editor. See your computer appendix for Specifics.

This section of the manual refers to the COMMAND window. Switching between the COMMAND and EDIT windows is accomplished with COMMAND E.

STANDARD LINE EDITOR

ENTERING AND DELETING LINES

Type in the following example. Enter it exactly as shown, as we will use this text to illustrate the use of the line editor. Remember to use <ENTER> at the end of each line. This is how ZBasic recognizes a line and stores it in memory:

```
10 THIS IS AN EXAMPLE OF ADDING A LINE
20 THIS IS THE SECOND LINE
30 THIS IS THE THIRD LINE
```

If you make a mistake use <BACKSP> or <DEL> to delete it. If you <ENTER> a line incorrectly just type it over again. To see the complete program type LIST:

LISTING A PROGRAM

To list a line, or range of lines, use **LIST** or just **L**:

YOU TYPE	ZBASIC RESPONDS
LIST or L	Lists the complete program to the screen
LIST "SUBROUTINE"	Lists the line with that label
LIST "FRED"-	List all lines after and including the line with the label "FRED"
LIST 100-200	Lists lines from 100-200
LLIST-100	Lists lines up to 100 to printer
LIST 100- or L100-	Lists lines from 100 on
<period>	Lists the last line listed or edited
<UP ARROW>	Lists previous line (or plus <+> key)
<DOWN ARROW>	Lists next line (or minus <-> key)
L+	Lists program without line numbers
LLIST+	Lists to printer without line numbers
L+-100	Lists up to line 100 without showing line numbers
<SPACE>	Single steps long listings. <ENTER> continues listing
</>	Lists PAGE of lines (10 lines) to screen
LIST*	Some systems: Highlights keywords on screen while listing

DELETING LINES

Deleting lines is accomplished in a number of ways. Examples:

YOU TYPE	ZBASIC RESPONDS
1000 <ENTER>	Deletes line 1000
DEL 1000	Delete line 1000
DEL 10-50	Delete lines 10 through 50
DELETE 50	Delete line 50
DELETE 50-	Delete line 50 and all lines after
NEW	Delete the entire program *Careful!*

NOTE: Labels may be used in place of line numbers (except first example)

ADDING OR INSERTING A NEW PROGRAM LINE

Add or insert a line by typing in a new line number followed by text (be careful not to use the number of a line already being used unless you want to replace it). To insert a line between line 10 and line 20, assign a number such as 15 to the new line (or another number between 10 and 20). To add a line at the end of the program, assign the line a number greater than the largest line in the program.

STANDARD LINE EDITOR

HOW TO EDIT TEXT ON A LINE

The Standard Line editor is used to edit lines in a program and to give commands directly to the compiler. Deleting inserting, changing or adding new text is easy and fast.

EDIT ANYTHING ON A LINE... EVEN LINE NUMBERS!

Unlike most BASICs, ZBasic allows you to edit anything on a line, even the line number. When a line number is edited, ZBasic creates a new line with that line number. The old line will not be deleted or changed. Very handy for avoiding redundant typing.

The ZBasic line editor functions the same way on all versions of ZBasic. Here are ALL the line edit keys you need to remember:

STANDARD LINE EDITOR KEYS

CURSOR MOVEMENT	DELETE TEXT	INSERT TEXT
<SPACE> Move RIGHT	**<D>**elete one character	**<I>**insert characters
<BACKSP> Move LEFT	**<K>**ill, Delete up to <letter>	e**<X>**tend line
<S>earch for <letter>	**<H>**ack to end of line	**<ESC>**ape Insert mode

OTHER	
<A>bort changes	**<C>**hange character under the cursor
<ENTER> Keep changes	**<BREAK>** Abort changes (CTRL C on some systems)

CURSOR ARROW keys are often used instead of <SPACE> and <BACKSP>.

Macintosh: <ESC>=<TAB>, <COMMAND Period>=<BREAK>. **MSDOS** and **Apple** //: Cursor keys=<SPACE> and <BACKSP>. Delete key also works as <BACKSP>. <CNTRL C>=<BREAK>. **MSDOS**: Insert key = <I>. **CP/M**: <CNTRL C>=<BREAK>. TRS-80: <SHIFT up-arrow>=<ESC>.

USING THE LINE EDITOR

The command to edit a line is "EDIT" (or just "E") followed by a line number (or label). If no line number is used, the last line LIST(ed) or EDIT(ed) will be assumed (<COMMA> without <ENTER> will also edit the current line).

"EDIT 20" and "E20" do the same thing.

The following page describes the simple commands used to edit the characters on the line.

STANDARD LINE EDITOR

LEARNING THE COMPLETE STANDARD LINE EDITOR IN 10 MINUTES OR LESS

LISTING THE LINE YOU ARE EDITING <L>

To see the complete line you are editing, and put the cursor at the beginning of the line, press the <L> key. Remember: Line editor commands do not require <ENTER>.

MOVING THE CURSOR ON THE LINE n <SPACE> <BACKSPACE>

To move the cursor back and forth on a line, use <SPACE> or <BACKSP> (<DEL> some systems) (don't use <ENTER>). To move the cursor multiple positions, use a number first.

SEARCH FOR CHARACTER n <S>

To move the cursor to a specific character on a line quickly, use the <S> key, (SEARCH), followed by the character to find. To move the cursor from the "T" in "THIS" to the "L" in "EXAMPLE", just type <S> and <L>.

```
00010 THIS IS AN EXAMPLE OF ADDING A LINE
00010 THIS IS AN EXAMP_
```

CHANGE CHARACTER UNDER CURSOR n <C>

To change the character under the cursor, press <C> followed by the new character. To change five characters, press the <5> key first, the <C> key, then the five keys to replace the old characters.

ABORT (UNDO) CHANGES <A>

To undo changes press the <A> key. All changes, additions and deletions will be aborted.

DELETE CHARACTERS n <D>

To delete characters in a line use the <D> key. Pressing <D> will delete the character under the cursor. To delete five characters press <D> 5 times or press the <5> key and the <D> key.

ESCAPE PRESENT MODE <ESC>

To escape from INSERT, SEARCH, CHANGE, EXTEND or KILL modes, press <ESC>.

DELETE UP TO A SPECIFIC CHARACTER n <K>

To delete, or KILL, a range of characters from the cursor to a specified character, use the <K> key.

INSERT CHARACTERS <I>

To insert text in a line, position the cursor where insertion is desired. Press the <I> key. Type in text or <BACKSP> to erase text. Almost any key may be typed except <ESC>, <ENTER> or <BREAK>.

<ESC>ape exits the INSERT mode.

DELETE TO END OF LINE <H>

To delete all the characters from the cursor position to the end of the line, press the <H> key (Hacks off the remainder of the line).

MOVE TO END OF LINE AND ADD <X>

To move the Cursor to the end of the line and enter the INSERT MODE, press the "X" key (For eXtend). <ESC> will return to the regular line editor mode.

EXIT THE LINE EDITOR <ENTER> or <BREAK>

<ENTER>: Exit the line edit mode and ACCEPT all changes and additions.
<BREAK>: To exit the line edit mode and IGNORE all changes and additions.

* n is a number. If you type 4D, four characters are deleted, n=nth occurrence or n times.

USING OTHER EDITORS OR WORD PROCESSORS

Most versions of ZBasic now come with a Full Screen Editor. Check your computer appendix to see if you have one for your version. If you choose, you may also edit ZBasic programs with a word processor or some other editor. You will need to save the ZBasic program in ASCII using the **SAVE* or SAVE+** commands before editing.

In order for ZBasic to load a text file it requires that:

Line lengths must be less that 250 characters
Every line must be followed by a Carriage Return

If the text file does not contain line numbers, ZBasic will assign line numbers to the program starting with one, in increments of one. Use RENUM to renumber a program. ASCII text takes longer to LOAD and SAVE.

RENUMBER PROGRAM LINES

ZBasic renumbers lines in a program using the RENUM command.
Format:

RENUM [[NEW LINE NUMBER][[, OLD START,][INCREMENT]]]

YOU TYPE	ZBASIC RESPONDS
RENUM	Lines start with 10, Increments of 10
RENUM 100,,5	Lines start with 100, Increments of 5
RENUM 100,20,5	Renumber From line 20, Start with 100, Increments of 5
RENUM,,100	Renumbers all lines by 100

THE CALCULATOR (DIRECT MODE)

ZBasic has a built in calculator. Use "?" or "PRINT" in front of a calculation to see the results. You may also convert number bases like HEX, Binary, Octal and Unsigned Integer. (See BASE CONVERSIONS) Examples:

YOU TYPE	ZBASIC RESPONDS
PRINT 123.2*51.3	6320.16
?SQR(92.1)	9.5968745
PRINT 3/2*6	6 (Calculated in INTEGER)
?3./2*6	9 (Calculated in FLOATING POINT)
?320/.0001	3200000

NOTE: Unless you have configured ZBasic to default to floating point, Integer is assumed. If configured for "Optimize expressions as Integer", use a decimal point in an expression to force the result of a calculation to be floating point (see CONFIGURE).

STANDARD LINE EDITOR

SAVE, LOAD, APPEND and MERGE

ZBASIC uses the LOAD and SAVE commands to load and save programs. Subroutines saved in ASCII without line numbers may be inserted in your program with APPEND.To SAVE in ASCII use "*". To SAVE ins ASCII without line numbers use "+". Examples:

SAVE MYPROG	Saves in tokenized format.
SAVE CHECKERS 2	Saves tokenized to TRS-80 drive 2.
SAVE* MYPROG	Saves MYPROG in ASCII.
SAVE+ TEST	Saves TEST without line#'s in ASCII.
LOAD CHECKERS	Loads Checkers.
LOAD* CHECKERS	Loads Checkers but strips REMarks and Spaces.
MERGE MYPROG	Merges program MYPROG.
MERGE* MYPROG	Merges ASCII program, strips REM's and Spaces.
APPEND 2000 MYSUB	Loads non-line# ASCII subroutine, MYSUB, to line 2000.
APPEND* 50 SORT	Loads SORT to line 50 in increments of 1, strips all REM's and Spaces from the routine.

NOTE: Only non-line numbered ASCII programs may be APPENDED (SAVE+). Only line numbered programs may be merged (SAVE or SAVE*).

When LOAD(ing) programs without line numbers, ZBasic assumes the end-of-line is terminated with <CR>, <CRLF> or 250 characters, whichever comes first. Lines are assigned line numbers starting with one, in increments of one.

FILE DIRECTORY OR CATALOG

To see the names of files on the current storage device type DIR. Examples:

MS-DOS (also see PATH and CHDIR)

Apple DOS 3.3 and **CP/M**:

DIR	Lists all the files on the present drive
DIR B:	Lists the files on drive B
DIR A:	Lists all the files on drive A
DIR C:	Lists all the files on drive C
	NOTE: The Apple DOS 3.3 version of ZBasic uses A, B, C... for drive specs instead of D1, D2...

APPLE ProDOS: (also see PATH)

DIR	Lists all files in current directory
DIR FRED	Lists all files in subdirectory FRED
DIR FRED/TOM	Lists all files in subdirectory TOM

TRSDOS:

DIR 0	Lists the files on drive zero
DIR 2	Lists the files on drive two
DIR 1	Lists the files on drive one

Macintosh: (also see FILES$)

DIR HD30:Fred	Lists files in folder called "Fred" on root directory call HD30
LDIR HD30:Fred	Lists all files to the printer

Be sure to see your COMPUTER APPENDIX for variations.

STANDARD LINE EDITOR

THE MINI-COMPILER (Direct mode similar to an interpreter)

The Mini-compiler permits compilation of one line programs while in the standard editor. This is very convenient for testing logic or math without having to run the entire program. You are limited to one line but may use a colon ":" to divide a line into multiple statements.

Remember to use ? or PRINT to see the results. Examples:

YOU TYPE	ZBASIC RESPONDS
PRINT LEFT$("HELLO",2)	HE
PRINT CHR$(65)	A
PRINT ASC("A")	65
FOR X=1 TO 500:? X;:NEXT	1 2 3 4 5 ...500
? ABS(TAN(1)* EXP(2)+ LOG(9))	13.704997622614
: LPRINT "HELLO"	Prints "HELLO" to the printer
PLOT 0,0 TO 1024, 767	Plots a line across the screen
? &AB	171 (HEX to decimal)

*Note: A Mini-Compiler line may not start with an "E" or "L" since these are used for abbreviations for EDIT and LIST. To do a command that starts with "E" or "L", use a colon ":" first; **:LPRINT**

THE FIND COMMAND

ZBASIC will FIND variables, quoted strings, labels, line numbers and commands within a program quickly and easily. In most cases simply type FIND followed by the text you want to find. The only two exceptions are:

1. To find quoted strings, use one leading quote; FIND "HELLO
   Note 1: First characters in quoted string are significant.
   Note 2: "A" and "a" are considered different characters.

2. Use "#" in front of a line number reference: FIND #1000

YOU TYPE		ZBASIC FINDS
FIND "HELLO		01010 A=20:PRINT"HELLO THERE"
FIND A$		01022 Z=1:A$=B$:PRINTA$+B$
	or...	01333 ABA$="goodbye"
FIND 99		05122 F=2:X=X+2+F/999
FIND #12345 (line number)		08000 GOTO 12345
FIND 100 (not a line number)		02000 X=100
FIND X(C)		03050 A=1:T=ABS(X(C)/9-293+F)
	or...	03044 ZX(C)=4
FIND PRINT		00230 A=92:PRINTA
FIND "SUB5		00345 "SUB500": CLS
	or...	03744 GOSUB "SUB500"
FIND OPEN		03400 OPEN"R",1,"FILE54",23
FIND X=X+2		09922 F=2:X=X+2+F/999
FIND <ENTER>		Finds next occurrence
<;> (semi-colon key)		Finds next occurrence

To FIND data in remarks or DATA statements use FIND REM ..., FIND DATA ...

Note: If your version of ZBasic comes with a full screen editor, you may have other FIND or REPLACE options. See your computer appendix for specifics.

STANDARD LINE EDITOR

SETTING CHARACTER WIDTH AND MARGINS FOR PROGRAM LISTINGS

ZBasic has powerful formatting commands for making program listings to the screen or printer easier to read.

WIDTH, WIDTH LPRINT AN DPAGE

Since screen and printer widths vary depending on the hardware, the user may set the width of listing to either the printer or the screen.

COMMAND	RESULT
WIDTH=0 THROUGH 255	Sets Screen width for listings.
WIDTH LPRINT= 0 THROUGH 255	Sets the printer width for listings.
PAGE 0-255(1), 0-255(2), 0-255(3)	Formats LINES PER PAGE for printer. (1) Desired lines printed per page (2) Actual lines per page (3) Top Margin

An example of using these commands for printer listings: To set the top and bottom margins to 3 lines each (to skip perforations) and the printer width to 132, type:

WIDTH LPRINT=132: PAGE 60,66,3

NOTE: WIDTH, WIDTH LPRINT and PAGE may also be used from within a program. Check the reference section for specifics. (In a program, the PAGE function returns the last line printed. The PAGE statement will send a form feed to the printer. A ZERO value disables all the functions above.

AUTOMATIC LOOP AND STRUCTURE INDENTING

For readability, loops are automatically indented two spaces. When WIDTH is set, lines that wrap around will be aligned for readability as in line 10. Completed loops on the same line will show an asterisk at the beginning of the line as in line 120:

LIST+ (without line numbers)

```
CLS: REM THIS IS A LONG
STATEMENT THAT CONTINUES...
FOR X= 1 TO 10
  DO G=G+1
    GOSUB "Graphics"
  UNTIL G=3
NEXT
"MENU"
CLS
END
"Graphics": X=0
DO X=X+16
  PLOT X, 0 TO X, 767
UNTIL X>1023
*FOR X= 1 TO 100: NEXT
RETURN
```

LIST (with line numbers)

```
00010 CLS: REM THIS IS A LONG
STATEMENT THAT CONTINUES...
00020 FOR X= 1 TO 10
00025   DO G=G+1
       00030       GOSUB "Graphics"
00035   UNTIL G=3
00040 NEXT
00050 "MENU"
00060 CLS
00070 END
00080 "Graphics": X=0
00090 DO X=X+16
       00100   PLOT X, 0 TO X, 767
00115 UNTIL X>1023
00120 *FOR X= 1 TO 100: NEXT
00125 RETURN
```

Note: LLIST*+ may also be used to do program listings to the Imagewriter or Laserwriter without line numbers and with keywords highlighted as above.

RUNNING ZBASIC PROGRAMS

RUNNING ZBASIC PROGRAMS

There are a number of ways to compile your programs with ZBasic. The most commonly used is a simple RUN. This lets you compile and debug interactively. Definitions:

RUN COMPILE PROGRAM IN MEMORY AND EXECUTE

The interactive mode is the easiest and fastest way to write and debug your programs. In many ways it is similar to a BASIC interpreter since you may:

1. **RUN a program to check for errors**
2. ***BREAK out of a running program by pressing <BREAK>.**
3. **Return to ZBasic to re-edit the program.**

Interactive compiling is limited to available memory. If a program gets too large you will have to use one of the methods below. ZBasic will tell you when this is necessary with and "Out of Memory" message.

RUN filename COMPILE PROGRAM FROM DISK AND RUN

If a program gets too large for interactive compiling using just RUN, the program text may be saved (not in ASCII), compiled, and executed. This is possible because the text to be compiled is no longer resident and frees up memory for the compiled program.

RUN* COMPILE PROGRAM IN MEMORY AND SAVE TO DISK
RUN* filename COMPILE FROM DISK AND SAVE TO DISK

Compiles the program from memory (RUN*) or disk (RUN* "filename") and saves it to disk. A few moments later ZBasic will request the filename of the resulting compiled program to be saved (For IBM or CP/M use a .COM suffix. For TRS-80 use a /CMD suffix).

This method frees up the most memory for the final program because the source code and ZBasic are no longer resident in memory. Compiled programs saved to disk are machine language programs and should be executed from the operating system like any other machine language program. See column three of the COMPILE MEMORY CHART.

RUN+ COMPILE PROGRAM IN MEMORY AND SAVE AS CHAIN PROGRAM
RUN+ filename COMPILE FORM DISK AND SAVE AS CHAIN

See CHAINING PROGRAMS for details.

RUNNING ZBASIC PROGRAMS

DETERMINING MEMORY REQUIREMENTS

MEM returns the available memory. (The table may vary on some versions).

TYPE MEM:		MEANING
00123	Text	Program text memory used (source code).
49021	Memory	Free memory.
00000	Object	Compiled program size of object code.*
00000	Variable	Memory required for variables.*

*Type **MEM** immediately after compiling to get the correct totals. At other times the results of "Object and Variable" may be invalid.

TYPICAL MEMORY USAGE BY "RUN" TYPE

RUN

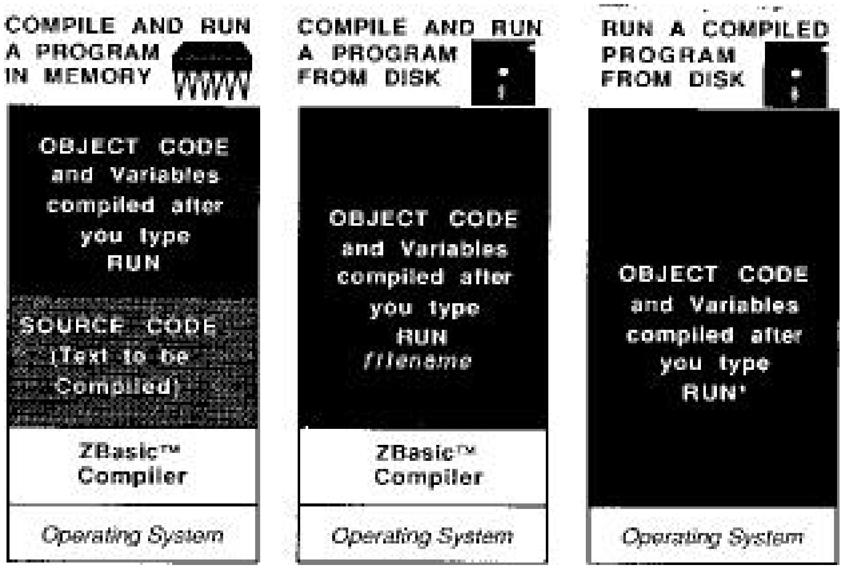
Program text is resident in memory with ZBasic, the compiled program and the variables used by that program. The user may press <BREAK> when running the program, re-enter

RUN filename

The program text is saved to disk and compiled from the disk to memory and RUN. Larger programs may be compiled this way because the program to be compiled is not in memory.
the editor and debug any mistakes and re-compile.

RUN* [filename]

The program is compiled from memory or disk and the resulting machine language program is saved to disk.
The program is executed as a machine language program.
When this program is executed the program text and ZBasic are no longer resident, leaving more memory for the program.


COMPILE AND RUN A PROGRAM IN MEMORY
OBJECT CODE and Variables compiled after you type RUN
SOURCE CODE (Text to be Compiled)
ZBasic™ Compiler
Operating System
COMPILE AND RUN A PROGRAM FROM DISK
OBJECT CODE and Variables compiled after you type RUN filename
ZBasic™ Compiler
Operating System
RUN A COMPILED PROGRAM FROM DISK
OBJECT CODE and Variables compiled after you type RUN*
Operating System

*See your Computer Appendix to determine actual memory usage.

RUNNING ZBASIC PROGRAMS

<BREAK>ING OUT OF RUNNING PROGRAMS

To make a program STOP when the <BREAK> key is pressed, use TRON, TRONS, TRONB or TRONX.

TRONB — Checks at the start of every line to see if the <BREAK> key has been pressed. If pressed ZBasic returns control to DOS or to the Standard line editor (if in interactive mode). To disable TRONB use the TROFF command.

TRONS — Single step trace. CNTR Z to engage/disengage any other key to single step through the program a statement at a time.

TRON — Displays line numbers during runtime.

TRONX — Checks for the <BREAK> key at the beginning of that line only.

NOTE: TRONX, TRON, TRONS and TRONB may cause INKEY$ to miss keys. TROFF turns all the TRON functions off. All TRONs will slow down programs AND increase size.

USING INKEY$ TO SET BREAK POINTS

You may also use INKEY$ to break out of a program. Put the following line in a program loop or wherever you may want to escape:

```
IF INKEY$="S" THEN STOP
```

Program will stop if the "S" key is pressed (any key could have been used).

CASES WHERE BREAK WILL NOT FUNCTION

Since ZBasic compiles your programs into machine language, there occurs certain situations where the <BREAK> key will be ignored. Remember; the <BREAK> key is checked only at the beginning of a line. The following example will not break:

```
TRONB
*FOR X= 1 TO 10: X=1: NEXT
```

This is obviously and endless loop (X never gets to 10). One obvious way around this is to avoid putting the entire loop construct on one line.

Examples of other cases where the <BREAK> key is ignored; INPUT, LINE INPUT, DELAY and SOUND statements.

Macintosh: <BREAK>=<COMMAND Period>. <CNTR Z>=<COMMAND <Z>. Most people use BREAK ON instead of TRONB with the Macintosh. See Appendix. **Apple** //: <BREAK> means: <CNTR C>, <CNTR RESET> may be preferable. **MSDOS**: <BREAK> means: <CNTR C>. **CP/M**: <BREAK> means: <CNTR C>: **TRS-80**: <BREAK> means the <BREAK> key.

CHAINING

CHAINING

CHAINING PROGRAMS TOGETHER

Chaining is convenient when programs are too large for memory and must be broken into smaller programs. There are three ways to chain programs:

o CHAIN WITH SHARED VARIABLES (GLOBAL or COMMON VARIABLES)
o CHAIN WITH INDEPENDENT VARIABLES
o CHAIN WITH SOME VARIABLES COMMON AND OTHERS NOT

Macintosh CHAIN programs are limited to 28k. See "SEGMENT" and "SEGMENT RETURN" in the appendix for instructions on using the Macintosh memory manager.

EXAMPLES OF CHAINING PROGRAMS WITH SHARED VARIABLES

Programs that will share variables must have those variables defined in exactly the same order in all the programs being chained. ZBasic allows common or shared variables to be DEFINED within **DIM** statements (even if they are not arrays). **CLEAR** or **CLEAR END** should always be used to clear variables that are not shared. Examples:

"STARTB"

```
DIM A(10),100A$(100),Z,F5,W99
OPEN"I",1,"PROG1"                :REM  Always execute this program 1st
RUN 1                            :REM  This is just a starter program
```

"CHAIN1"

```
REM  THIS IS PROG1
TRONB: REM ENABLE <BREAK> KEY
DIM A(10),100A$(100),Z,F5,W99
CLEAR END
TV=23: PR=4
CLS: PRINT"THIS IS PROGRAM #1"
PRINT"Z=";Z,"F5=";F5
Z=RND(10) :F5=RND(10)
PRINT"Z=";Z;" F5=";F5
PRINT"JUMPING TO PROGRAM #2"
DELAY 2000
OPEN"I",1,"PROG2"
RUN 1: REM  RUNs Prog2
```

"CHAIN2"

```
REM  THIS IS PROG2
TRONB
DIM A(10),100A$(100),Z,F5,W99
CLEAR END
ZZ=99: MYVAR=9191
PRINT "THIS IS PROGRAM #2"
       PRINT"Z=";Z,"F5=";F5
Z=RND(10) :F5=RND(10)
PRINT"Z=";Z;" F5=";F5
PRINT"JUMPING TO PROGRAM #1"
DELAY 2000
OPEN"I",1,"PROG1"
RUN 1:REM RUNs Prog1
```

CHAINING

COMPILING THE EXAMPLE PROGRAMS

1. RUN* STARTB and save as START
   Always RUN* a START program. This is a dummy program and is used only to get the chained programs started and contains the runtime routines. Any filename will do.

2. RUN+ CHAIN1 and save as PROG1
3. RUN+ CHAIN2 and save as PROG2

NOTE: Always compile a START program using the RUN* command so that the chained programs have a runtime package. All chained programs must be compiled using RUN+.

USE "DIM" TO DEFINE SHARED OR COMMON VARIABLES

When chained together, both PROG1 and PROG2 will share variables defined on line 10 after the DIM. If F5 equals 10 in PROG1, it will still equal 10 when you RUN PROG2.

Because variables "TV" and "PR" are unique to PROG1 and the variables "ZZ" and "MYVAR" are unique to PROG2, CLEAR END must be used to initialize them (they must be assigned values). Otherwise false values will be passed from other CHAIN programs.

The example programs (PROG1 and PROG2) will chain back and forth until you press <BREAK>. Lines 80 and 90 are where the programs branch off to the other program.

CLEARING NON-SHARED VARIABLES WHEN CHAINING

Always use CLEAR END to clear variables that are not common between the programs. All variables that follow a CLEAR END will be unique to that program and will start out as null values.

```
(1)                                 (2)
10 DIM 200A$(100), 65B$(300)        10 DIM 200A$(100), 65B$(300)
20 CLEAR END                        20 CLEAR END
30 DIM FR(900)                      30 A9=10: Z=33
```

In the above examples, the array variables A$ and B$ are shared and will contain the same values, while all other variables in the program following the CLEAR END statement will be null or zero and unique to that program. FR(n) is unique to program (1) and A9 and Z are unique to program (2).

This statement may be used in non-chained programs as well. It is a handy way to null or zero out selected variables (the variables still exist, they are just set to zero or null).

CHAINING PROGRAMS WITHOUT SHARING VARIABLES

This is done exactly as the same as the previous examples for shared variables, except CLEAR is used on the first line of each chained program.

In the example programs CHAIN1 and CHAIN2, add a line:

```
3 CLEAR
```

Variables are not shared and CLEAR clears all variables (sets them to zero or null) each time a program is entered or chained.

To selectively share some variables and not others use the CLEAR END statement described on the previous page and in the reference section.

ERRORS

ERRORS

There are different types of error messages. When errors are encountered during compilation, compiling is stopped and the offending line is displayed. This is a Compile Time error. Errors encountered during execution of a program are called Runtime Errors.

COMPILE TIME ERRORS

After typing RUN, ZBASIC compiles the program. If errors are encountered, ZBASIC will stop compiling and display the error on the screen along with the offending line (when compiling form disk using RUN "Filename" or RUN*, ZBasic will stop compiling, load the Source Code, and LIST the line where the error occurred.) The Statement within the line and the line number will be displayed. The following program would cause ZBASIC to print an error during compile:

```
00010 CLS
00020 PRINT "HELLO THERE MR. COMPUTER USER!"
00030 PRINT "I AM A COMPUTER"
00040 Z=Z+1: X=X+Z: PWINTX
```

RUN

```
Syntax Error in Stmt 03 at Line 00040
00040 Z=Z+1: X=X=Z: PWINT X
```

NOTE: The error will be marked in some way depending on the computer system being used. The error marker indicates the general error location on the line where compilation stopped. To edit line 40 above type: EDIT 40 (or just comma). Fix the spelling of PRINT.

ZBasic will often display the missing character it expected.

```
00010 INPUT"Enter a number" A$
RUN
";" expected error in Stmt 01 at line 00010
00010 INPUT"Enter a number"_A$
```

```
00010 DIM A(10,10)
00020 A(X)=100
RUN
"," expected error in Stmt 01 at line 00020
00020 A(X_)
```

ERRORS

COMPILE TIME ERROR MESSAGES

A compile time error is one that ZBasic encounters after you type RUN (while it is compiling your program). More often than not, the error is a syntax error. Edit the line to fix the error an type RUN again until all the errors have been deleted.

COMPILE TIME ERROR MESSAGE	DEFINITIONS and POSSIBLE REMEDIES
DIM Error in Stmt...	Only constants may be used in DIM statements: DIM A(X) or Z(A+4) are not allowed. If you have a need to erase and reuse dynamic staring arrays see: INDEX$, CLEAR INDEX$, MEM.
No DIM Error in ...	Array variable being used was not Dimmed. Make sure variable is Dimmed correctly. Most interpreters allow ten elements of an array before and DIM is required. A compiler requires a DIM for every array.
Overflow Error in ...	DEF LEN or DIM string length is less than one or greater than 255. Also if CLEAR =zero or CLEAR is too large. Check an d adjust range.
Syntax Error in ...	Anything ZBasic does not understand. Check for spelling, formatting errors and syntax. The offending part of the line is often highlighted.
Too Complex Error...	String function is too complex to compile. Break up complex strings.
Re-DEF Error...	An FN or LONG FN was defined twice.
Variable Error in...	String assignment problem: A$=123:Change to A$=STR$(123)
Out of Memory Error in...	Program is getting too large. Check large DIM statements and defined string lengths, or compile using RUN*. For very large programs you may wish to CHAIN programs together.
Line # Error in...	GOTO, GOSUB, ON GOTO, ON GOSUB, THEN or some other branching command can't find line number or a label.
Mismatch error in...	The assignment to a variable is the wrong type.
Structure Error in...	FOR without NEXT, DO without UNTIL, WHILE without WEND, LONG IF without END IF or LONG FN without and END FN.
Structure Error in 65535*	Missing NEXT, WEND, END IF, END FN, or UNTIL. If unable to find error quickly, LLIST the program. structures are indented two spaces. backtrack from the end of the program until the extra indentation is located.
"?" Expected error in ...	ZBasic expected some form of punctuation that was not provided. Check cursor position in displayed line for error.

*NOTE: Each ZBasic loop command must have one, and only one, matching partner. Each FOR need a NEXT, each WHILE needs a WEND, each LONG FN needs and End FN, each LONG IF needs an END IF and each DO needs an UNTIL.

ERRORS

RUN TIME ERRORS

A Run Time (execution) error is an error that occurs when the compiled program is running (Object Code). The only Run Time error messages produced are:

DISK ERRORS (Unless trapped by the user). See Disk Errors in the FILES section of this manual.

OUT OF MEMORY ERROR when loading a compiled program saved to disk that is too large to execute in memory.

ARRAY BOUNDS ERROR will be shown if the user configures ZBasic to check for this. This will slow down a program execution but is extremely handy during the debug phase of programming. You may turn this off after the program is completely tested. If access to an array element out of bounds is made, the program is stopped and the line number with the error printed.

STRING LENGTH ERROR. Some versions of ZBasic have a configure option that tells ZBasic to check for string assignments greater than the length allowed. This does slow execution speed and add memory overhead, so you may want to remove this error checking after the program is debugged. See your appendix for specifics. If an attempt is made to assign a string a value longer than its length, the program is stopped and the line number with the error is printed.

RECOVERING FORM FATAL RUNTIME ERRORS

Since ZBasic is a compiler and converts your code into machine language, there is always a risk that you may unintentionally enter an endless loop or hang up the system (the computer will not respond to anything).

In these instances you may not be able to get a response form the computer or be able to <BREAK> out o f the program. The system may have to be reset or turned off, and back on again to regain control. To avoid losing valuable time, it is very important that you SAVE PROGRAMS and MAKE BACKUPS FREQUENTLY. See you computer appendix for possible alternatives.

USING SINGLE STEP DEBUGGING TO FIND THE SOURCE OF "CRASHES"

Should you encounter a situation where your program goes so far and then the system hangs-up or you get a system error of some kind that you just can’t locate, there is a simple way to find the problem.

First put a TRONS and TRON in the program somewhere before the crash occurs. The TRON is added so that you can see a listing of the line numbers as the program executes. Press the space bar a statement at a time, keeping track of the line numbers as they go by.

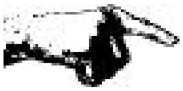
When the system crashes, make a note of the line number where the crash occurred and fix the problem in your program.

TERMS AND DEFINITIONS

TERMS AND DEFINITIONS

TERMS AND DEFINITIONS

I use terms throughout this manual that may be unknown to you. The following terms are used to make reading the technical information easier.



IMPORTANT NOTE

"The Hand" is pointing out something of importance for that section. Read it!

OPTIONAL

Items [enclosed in brackets] are OPTIONAL. You may or may not include that part of a command, function or statement.

REPETITION

Three periods (ellipsis) mean repetition ... when they appear after the second occurrence of something.

PUNCTUATION

Any punctuation such as commas, periods, colons and semi-colons included in definitions, other than brackets or periods described above, must be included as shown. Any text in Courier font, like this: COURIER FONT TEXT, means it is something for you to type in or a simulation of the way it will look on your screen like a program listing.

COMPUTER APPENDIX

Refers to the appendix in the back of this manual, ABOUT YOUR COMPUTER.

SPECIAL ^{32}

The superscripted 32 means this command, function or statement only works on 32 bit computers. See you COMPUTER APPENDIX to see if your computer supports 32 bits. In this edition of the manual it refers to the Macintosh computer only.

ABBREVIATIONS

Frequently used line editor commands have convenient abbreviations:

USE WITH <ENTER>		USE WITHOUT <ENTER>	
?	PRINT	,comma	EDIT present line
DEL	DELETE	.period	LIST present line
E	EDIT	/slash	LIST next 10 lines
L	LIST	;(semi-colon)	FIND next occurrence

TERMS AND DEFINITIONS

DIFFERENT (KEY) STROKES FOR DIFFERENT FOLKS

Since ZBASIC operates on many different computers, reference is made to the same keys throughout this manual.

MANUAL USES	YOUR COMPUTER MAY USE
<SPACE>	SPACE BAR
<BACKSP>	BACKSPACE, DELETE, LEFT ARROW
<BREAK>	CONTROL C, COMMAND PERIOD
<ENTER>	RETURN, CARRIAGE RETURN
<ESC>	ESCAPE, CNTRL UP ARROW, TAB
<UP ARROW>	CURSOR UP, PLUS KEY<+>
<DOWN ARROW>	CURSOR DOWN, MINUS KEY<->
<letter>	Press the Key with that letter

See your COMPUTER APPENDIX for variations or enhancements.

LABELS ON LINES

A line may have a label directly following the line number consisting of upper or lowercase, alphanumeric characters, or symbols in any order enclosed in quotes. The length of a label is limited to the length of a line. ZBasic recognizes only the first occurrence of a label.

Line numbers are essential only for line EDIT(ing), MERGE, and APPEND. Statements like; LIST, EDIT APPEND, GOTO, ON GOTO, GOSUB, ON GOSUB, DEL, etc., may use either Labels or line numbers. List programs without line numbers by using LIST+.

SIMPLE STRINGS

Quoted strings: "Hello", "This is within quotes"

Any String variables: A$, NAME$, FF$, BF$(23).

Any of the following string functions:
MKI$, MKB$, CHR$, HEX$, OCT$, BIN$, UNS$, STR$, ERRMSG$, INKEY$, INDEX$(9).

COMPLEX STRINGS

Complex strings are any combination of SIMPLE STRINGS. Any string operations containing one of the following commands: simple string + simple string, LEFT$, RIGHT$, MID$, STRING$, SPACE$, UCASE$

ZBasic allows only one level of COMPLEX STRING expression. Complex strings MAY NOT be used with IF THEN statements. Convert all multi-level complex strings to simple strings:

CHANGE COMPLEX STRINGS	TO SIMPLE STRINGS
`B$=RIGHT$(A$+C$,2)`	`B$=A$+C$:  B$=RIGHT$(B$,2)`
`B$=UCASE$(LEFT$(A$,3))`	`B$LEFT$(A$,3): B$=UCASE$(B$)`
`IF LEFT$(B$,2)="IT"THEN 99`	`D$=LEFT$(B$,2): IFD$="IT"THEN 99`

The Macintosh version allows much deeper levels of complex strings.

TERMS AND DEFINITIONS

VARIABLE TYPES

A$, A#, A!, A%, and A%(n,n) represent different variables. If no type is given, integer is assumed (unless configured differently by the user or changed with DEF DBL, DEF SNG or DEF STR). A and A% would be the same variable. Types:

%	Integer variable
&	4 byte Integer (32 bit machines only)
!	Single precision variable
#	Double precision variable
$	String variable

EXPRESSIONS

Throughout this manual reference is made to expressions. There are different types of expressions and the following words will be used to refer to specific expressions.

DEFINITION OF EXPRESSION

EXPRESSION refers to a combination of constants, variables, relational operators or math operators in either integer, floating point or string used to yield a numeric result. The following UNDERLINED examples are EXPRESSIONS.

```
CLEAR 2000

A= T+1

TEST= X^ 2.23* 5+1

IF X*3.4 <= Y*98.3 THEN   Z= 45*84^R

IF A$>B$ AND B$<>C$   THEN GOTO 1000
```

TERMS AND DEFINITIONS

BYTE EXPRESSION

A **BYTE EXPRESSION** always results in a number from 0 to 255. The expression may be floating point, integer or string, but if the actual result is more than 255 or less than 0, the final result will return the positive one byte remainder. ZBasic will not return an error if the calculation result is out of this range.

INTEGER EXPRESSION

An **INTEGER EXPRESSION** results in an integer number form -32768 to 32767. The expression may be floating point, integer or string, but if the actual result is more than 32767 or less than -32768, the final result will return the integer remainder which is incorrect. ZBasic will not return an error if the calculation result is out of integer range.

Note: 32 bit computers have a LongInteger range of +-2,147,483,647.

UNSIGNED INTEGER EXPRESSION

An **UNSIGNED INTEGER EXPRESSION** always results in an unsigned integer number from 0 to 65535. The expression may be floating point or integer but if the actual result is more than 65535 or less than 0 the final result will return the remainder which will be incorrect. See UNS$ for displaying signed integers as unsigned.

Note: 32 bit computers have an unsigned LongInteger range of 0 to 4,294,967,300.

CONDITIONAL EXPRESSION

Conditional expressions like A=B, A>B, A<B etc., will return negative one if TRUE(-1), and zero (0) if FALSE.

It should be noted that a condition like IF X THEN... would be TRUE if X is non-zero and FALSE if X=zero.

IMPORTANT NOTE ABOUT MATH EXPRESSIONS: If you have configured numeric expressions to be optimized as integer, the final result of an expression will be evaluated by ZBasic as integer UNLESS one of the following conditions is found within that expression:

* Constant with a type of (#, !, or exponent: D or E)
* Constant with a decimal point (period). Example: .34 or 1.92
*Non-integer variable. (Single or Double precision #, !)
* MATH Functions: COS, SIN, ATN, SQR, LOG, EXP, TAN, VAL, CVB, FRAC, AND FIX.
* Floating point math symbols \, ^ or [

Note: One expression may be made up of other expressions within parentheses. Each expression is evaluated separately and must meet the criteria above.

MATH OPERATORS

+	ADDITION
-	SUBTRACTION
*	MULTIPLY
/	DIVIDE
\	DIVIDE (Floating point Divide or Integer Divide)* * If configured as "Optimize Expressions as Integer" the \ is forced floating point divide, otherwise it is forced integer divide.
^ or [	EXPONENTIATION (raise to the power)
MOD	REMAINDER OF INTEGER DIVIDE (MODulo)
<<	SHIFT LEFT (BASE2 MULTIPLY)
>>	SHIFT RIGHT (BASE2 DIVIDE)

NEGATION

Negation will reverse the sign of an expression, variable or constant. Examples: -A, -12, -.32, -(X*B+3^7), -ABS(Z*R)

SHIFT (binary multiply and divide)

Since computers do internal calculations in binary (BASE 2), SHIFT is used to take advantage of this computer strength. Multiply or divide SHIFTS are faster than floating point multiply or divide and may be used when speed is a factor. (Integer Shift Right loses sign). A good example; ATN(1)<<2 = pi (instead of the slower; ATN(1)*4)

>>n	Shift right (Divide by 2^n)
<<n	Shift left (Multiply by 2^n)
	(n Truncates to an integer number)

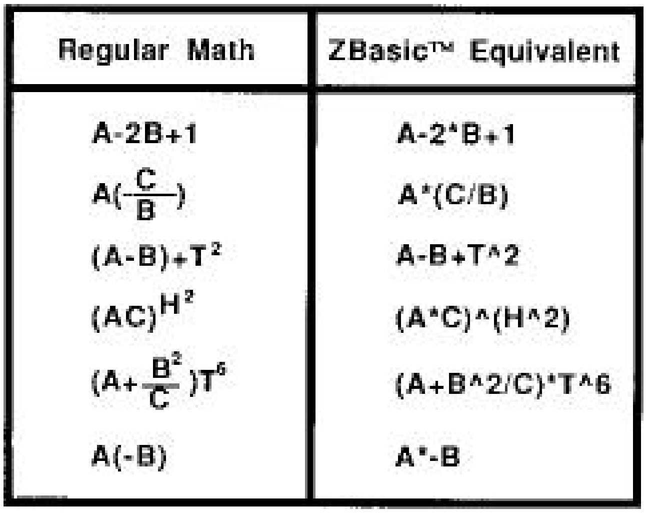
SHIFT FUNCTIONS	BASE 2 Equivalent*	DECIMAL Equivalent	RESULT
4>>1 (Divide)	4/2^1	4/2	2
4<<1 (Multiply)	4*2^1	4*2	8
89.34<<2	89.34*2^{2}	89.34*4	357.36
.008>>1	.008/2^{1}	.008/2	4E-3
999.>>7	999/2^{7}	999/128	7.8046875

*2^{1}=2, 2^{3} is the same as 2*2*2, 2^7 is the same as 2*2*2*2*2*2*2
With 10>>8.231 or 10<<8.231 the 8.231 would be converted to integer 8

MATH

REGULAR MATH EXPRESSIONS AND ZBASIC EQUIVALENTS

Regular math and algebraic expressions are quite similar to ZBasic expressions. The user should, however, be aware of some important differences. As in regular algebraic expressions, parentheses determine the part of the expression that is to be completed first. Examples:



Regular Math	ZBasic™ Equivalent
A-2B+1	A-2*B+1
$A(\frac{C}{B})$	A*(C/B)
$(A-B)+T^2$	A-B+T^2
$(AC)^{H^2}$	(A*C)^(H^2)
$(A+\frac{B^2}{C})T^6$	(A+B^2/C)*T^6
A(-B)	A*-B

FORCING EXPRESSION EVALUATION TO DEFAULT TO FLOATING POINT

ZBasic normally optimizes expression evaluation by assuming integer if no floating point types are seen in the expression. This can cause confusion for those used to MSBASIC or other languages without this capability. Setting "OPTIMIZE EXPRESSIONS FOR INTEGER MATH?" to "NO" sets the expression evaluator to interpret expressions as most other computer languages do; that is, all expressions will default to floating point if parentheses or any part of the expressions contain a floating point operator. While this makes it easier to follow the logic in an expression, the speed of execution time will suffer greatly.

It should be noted that a compiler cannot determine if an expression like C%=A%*B% returns a floating point number. If A%=20000 and B%=20000 an overflow will occur.

NOTE: Some versions of ZBasic, most notably versions older than 4.0, will not allow you to configure the expression evaluator. Older versions default to optimized integer math as described below.

WHY OPTIMIZE EXPRESSIONS FOR INTEGER MATH?

ZBasic defaults to a unique way of interpreting math expressions. Under CONFIGURE, you are given the option of setting expression evaluation to optimized integer or regular floating point. The default is INTEGER. This requires some extra thought on the part of the user but forces programs to execute much faster and much more efficiently.

UNDERSTANDING EXPRESSIONS THAT ARE OPTIMIZED FOR INTEGER MATH

Optimized Integer Expressions return the final result of an expression in integer or floating point, depending on how the expression is evaluated.

To optimize program speed and size, *integer is assumed UNLESS one of the following is found in an expression: decimal Point, scientific function, \(floating point divide: SEE NEXT PAGE DEFINITIONS OF DIVIDE SYMBOLS) , #, ! or a constant>65,535.

The following examples will give you an idea how ZBasic evaluates expressions as Integer or floating point. (B=10)

EXPRESSION	RESULT	EXPRESSION EVALUATED AS
B* .123	1.23	FLOATING POINT (Decimal point force REAL)
B* 23	230	INTEGER
B *23#	230	FLOATING POINT (# forces Double Precision)
B* 32000	-11264	INTEGER (Overflow error)
B* 32000.	320000	FLOATING POINT (Decimal point)
SIN(B)	-.54402111	FLOATING POINT (Scientific Function)
B*0+65535	-1	INTEGER (UNS$(-1)=65535)
B*4800	-17536	INTEGER (UNS$(-17536)=48000)

*Note: You may configure ZBasic to assume floating point by setting "Optimize expressions for integer math" to "NO". See "Configure" in the beginning of this manual.

PARENTHESES IN OPTIMIZED INTEGER EXPRESSION EVALUATION

Parentheses are used to force an expression to be evaluated in a certain order. (See ORDER OF PRECEDENCE)

ZBasic evaluates an expression by examining the outermost portions. In the expression: X*(2*(4.03+4))*5, the innermost portion of 4.03+4 is floating point, but since the outermost portions of X* and *5 are integer the whole expression is returned as an integer. (B=10 in examples)

EXPRESSION	RESULT	EXPRESSION EVALUATED AS
B*(32000+1)	-7670	INTEGER (Out of range error)
B*(32000.+1)+0!	320010	FLOATING POINT (! forces REAL)
B+(.23)+1200	1210	INTEGER
B+(.23)+1200.	1210.23	FLOATING POINT (period forces REAL)
B+(200*(.001^2))	10	INTEGER
B+200*.001^2	10.0002	FLOATING POINT
B+ATN(2)	11.107149	FLOATING POINT (Scientific Function)

The expression within each level of parentheses is still evaluated according to the precision in that level.

NOTE: Newer versions of ZBasic may be configured to expression evaluation you are more used to . See "OPTIMIZE EXPRESSIONS FOR INTEGER MATH" above.

MATH

INTEGER AND FLOATING POINT DIVIDE SYMBOLS

It should be noted that the Divide symbols / and \ take on different meanings depending on the type of expression evaluation being used:

Optimized for Integer "YES"	**Optimized of Integer "NO"**
/ = Integer Divide	/ =Floating Point Divide
\ =Floating Point divide	\ =Integer Divide

SCIENTIFIC FUNCTIONS

ZBasic offers several scientific and trigonometric math functions for making many calculations easier.

SQR(expression) SQUARE ROOT of expression.
Returns the number multiplied by itself
that equals expression. SQR(9)=3

LOG(expression) Natural LOGARITHM if expression
(sometimes referred to as LN(n)).
Common LOG10 =LOG(n)/LOG(10)

EXP(expression) Natural logarithm base value:
e=2.718281828459045235602874135266249775724
TO THE POWER of EXPRESSION. Inverse of LOG.

LOG and EXP may speed up calculations dramatically in certain situations. Some comparative equalities using LOG and EXP:

X*Y	**=**	**EXP (LOG(X) + LOG(Y))**
X/Y	**=**	**EXP (LOG(X) - LOG(Y))**
X^Y	**=**	**EXP (LOG(X) * Y)**

CONFIGURING SCIENTIFIC ACCURACY

Scientific function accuracy may be configured up to 54 digits of accuracy (32 bit machines may be higher). Default accuracy is 6 digits. Scientific accuracy may be configured from two digits of accuracy, up to Double Precision accuracy (not necessarily the same as Single or Double precision).

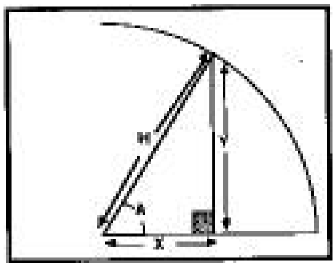
Precision is set when loading ZBasic under <C>onfigure. Scientific math functions are complicated; the more digits of precision used, the longer the processing time required. See "Setting Accuracy" in the floating point section of this manual for information about accuracy, speed charts and memory requirements.

SCIENTIFIC MATH SPEED

When speed is more important than accuracy, configure DIGITS OF PRECISION (under configure at start-up) to 6 digits for DOUBLE, 4 digits for SINGLE and 6 digits for SCIENTIFIC.

MATH

TRIGONOMETRIC FUNCTIONS



TAN(expr) TANGENT of expression in radians.
TAN(A)=Y/X, X=Y/TAN(A), Y=TAN(A)*X

ATN(expr) ARCTANGENT of the expression in radians.
A=ATN(Y/X), Pi=ATN(1)<<2

COS(expr) COSINE of the expression in radians.
COS(A)=X/H, H*COS(A)=X, X/COS(A)=H

SIN(expr) SINE of the expression in radians.
SIN(A)=Y/H, Y=H*SIN(A), H=Y/SIN(A)

SQR(expr) SQUARE ROOT of expression.
H=SQR(X*X+Y*Y)

TAN, ATN, COS AND SIN return results in Radians.

OTHER ZBASIC MATH FUNCTIONS

FRAC(expr) Returns FRACTIONAL portion of an expression
FRAC(23.232)-.232, FRAC(-1.23)=-.23

INT(expr) Returns expression as a whole number
INT(3.5)=3, INT(99231.2)+0=99231

SGN(expr) Returns the SIGN of an expression
SGN(-23)=-1, SGN(990)=1, SGN(0)=0

ABS(expr) Returns the ABSOLUTE VALUE of an expression
ABS(-15)=15, ABS(152)=152, ABS(0)=0

FIX(expr) Returns the whole number of an expression
FIX(99999.23)=99999, FIX(122.6231)=122
(Like INT but forces floating point mode)

expr **MOD** expr Returns the remainder of an integer divide (MODulo)
9 MOD 2=1, 10 MOD 2=0, 20 MOD 6=2

RND(expr) Returns a random number between 1 and expr
RND(10) randomly returns 1,2,3,4...10

MAYBE Randomly returns -1 or 0. (50-50 chance)
IF MAYBE PRINT "HEADS" ELSE PRINT "TAILS"

MATH

DERIVED MATH FUNCTIONS

MATH FUNCTION	TERM	ZBasic EQUIVALENT EQUATION
PI	(∏) PI	ATN(1)<<2 (accurate to double precision)
e	e	EXP(1)
Common LOG 10	LOG	LOG(X)/LOG(10)
Area of a CIRCLE	∏R^2	Y#=(ATN(1)<<2)*Radius*Radius
Area of a SQUARE		Y#=Length*Width
Volume of a RECTANGLE		Y#=Length*Width*Height
Volume of a CUBE		Y#=Length*length*length
Volume of a CYLINDER		Y#=(ATN(1)<<2)*Height*Radius*Radius
Volume of a CONE		Y#=(ATN(1)<<2)*Height*Radius*Radius/3
Volume of a SPHERE		Y#=(ATN(1)<<2)*Radius*Radius*Radius*4/3
SECANT	SEC(X)	Y#=1/COS(X)
COSECANT	CSC(X)	Y#=1/SIN(X)
COTANGENT	COT(X)	Y#=1/TAN(X)
Inverse SINE	ARCSIN(X)	Y#ATN(X/SQR(1-X*X))
Inverse COSINE	ARCCOS(X)	Y#ATN(1)*2-ATN(X/SQR(1-X*X))
Inverse COSECANT	ARCCSC(X)	Y#ATN(1/SQR(X*X-1))+(X<0)*(ATN(1)<<2)
Inverse COTANGENT	ARCCOT(X)	Y#=ATN(1)*2-ATN(X)
Hyperbolic Sine	SINH(X)	Y#(EXP(X)-EXP(-X))/2.
Hyperbolic Cosine	COSH(X)	Y#=(EXP(X)+EXP(-X))/2.
Hyperbolic Tangent	TANH(X)	Y#=(EXP(X)-EXP(-X))/(XP(X)+EXP(-X))
Hyperbolic Secant	SECH(X)	Y#=2./(EXP(X)+EXP(-X))
Hyperbolic Cosecant	CSCH(X)	Y#=2./(EXP(X)-EXP(-X))
Hyperbolic Cotangent	COTH(X)	Y#=(EXP(X)+EXP(-X))/(EXP(X)-EXP(-X))
Inverse Hyperbolic Sine	ARCSINH(X)	Y#=LOG(X+SQR(X*X+1))
Inverse Hyperbolic Cosine	ARCCOSH(X)	Y#=LOG(X+SQR(X*X-1))
Inverse Hyperbolic Tangent	ARCTANH(X)	Y#=LOG((1+X)/(1-X))/2
Inverse Hyperbolic Secant	ARCSECH(X)	Y#=LOG((1+SQR(1-X*X))/X)
Inverse Hyperbolic Cosecant	ARCCSCH(X)	Y#=LOG((1-SGN(X)*SQR(1+X*X))/X)
Inverse Hyperbolic Cotangent	ARCCOTH(X)	Y#=LOG((X+1)/(X-1))/2
Derivative of LN(X) (Natural LOG)		Y3=1/X
Derivative of SIN(X)		Y#=COS(X)
Derivative of TAN(X)		Y#=1+TAN(X)^2
Derivative of COT(X)		Y#=-(1+(1/TAN(X)^2)))
Derivative of ARCSIN(X)		Y#=SQR(1-X*X)
Derivative of ARCCOS(X)		Y#=-SQR(1-X*X)
Derivative of ARCTAN(X)		Y#=1/(1+X*X)
Derivative of ARCCOT(X)		Y#=1/(X*X+1)
Derivative of ARCSEC(X)		Y#=1/(X*SQR(X*X-1))
Derivative of ARCCSC(X)		Y#=-1/(X*SQR(X*X-1))
Derivative of ARCSINH(X)		Y#=1/SQR(1+X*X)
Derivative of ARCCOSH(X)		Y#=-1/SQR(X*X-1)
Derivative of ARCTANH(X)		Y#=1/(1-X*X)
Derivative of ARCCOTH(X)		Y#=-1/(X*X-1)
Derivative of ARCSECH(X)		Y#=-1/(X*SQR(1-X*X))
Derivative of ARCCOSSECH(X)		Y#=-1/(SQR(1+X*X))

See DEF FN and LONG FN for adding these math functions to your programs.

MATH

ORDER OF PRECEDENCE

In order to determine which part of a math expression is done first an order of precedence is used. The following math operators are performed in the this order.

1. (((1st)2nd)3rd)	Innermost expressions within parentheses always performed first
2. -	Negation (not subtraction)
3. NOT	Logical operator
4. ^ or [	Exponential
5. *,/,\,MOD	Multiply, Divide, Floating point Divide, MODulo
6. +,-	Addition, Subtraction
7. =,>=,=>,<=,=<, >,<,<>,><	Conditional operators
>>, <<	Shifts
8. AND, OR, XOR	Logical operator

ZBasic will calculate each operation of an expression in order of precedence, as defined by the table above. The final result of an expression depends on the order of operations.

If there are items of equal precedence in a n expression, ZBasic will perform those operations from left to right.

```
A#=2+5-3*6+1/4
```

This expression is performed in the following order;

1. 3*6
2. 1/4
3. 2+5
4. (2+5) - (3*6)
5. (2+5-(3*6)) + (1/4.)

```
A#=-10.75
```

Important Note: If expressions are optimized for Integer Math, the decimal point after the 4 forces the result of the expression to be floating point. If the decimal point had been omitted, the result would be -11. See CONFIGURE.

USING PARENTHESES TO FORCE PRECEDENCE

Parentheses are used in math expressions to force ZBasic to calculate that part of an expression first. If a math operation is enclosed in parentheses, which in turn is enclosed within parentheses, the innermost expression will be calculated first.

```
A#=2+5-3*6+1/4
```

To force the 2+5-3 part of the above equation to be calculated first, and then multiply that by 6 and add 1 second, with division by 4 last, you would express the equation like this:

```
A#=( (2+5-3) * 6+1) / 4.
```

The order of operations in this expression would be:

```
1.   (2+5-3)
2.   (2+5-3)*6+1
3.   ((2+5-3)*6+1)/4.

                       A#=6.25
```

Note: If Expressions are optimized for Integer Math; the outermost expression is used by ZBasic to determine whether the final result will be returned as integer or floating point.

The decimal point after the 4 forces the expression to be calculated as floating point (although each expression within parentheses is evaluated as floating point or integer depending on the rules of expressions). If the decimal point had been omitted the result would have been 6.

To use the standard rules of expression evaluation, set "Optimize Expression evaluation to Integer" to NO under configure. Math expressions will be done in the usual manner if this is done.

CONDITIONAL OPERATORS

The conditional operators return:

0 (zero)	If the Comparison is FALSE
-1 (negative one)	If the Comparison is TRUE
A non-zero expression	Is always TRUE
A zero expression	Is always FALSE

These symbols are used for comparing expressions and conditions.

=	Equal To
<>,><	Not Equal To
<	Less Than
>	Greater Than
>=, =>	Greater Than OR Equal To
<=, =<	Less Than OR Equal To

Examples: (A$"HELLO" AND A%=2000)

CONDITIONAL EXPRESSION	**RESULT**
X=12<20	X=-1
PRINT 23=45	0
IF 10>5 THEN PRINT "SURE IS"	SURE IS
IF A%-2000>100-99 PRINT A%	Nothing
IF VAL(A$)=0 THEN PRINT A$	HELLO
PRINT 2>5, 3<5, 5>5	0 -1 0
IF A%>120 THEN PRINT "OK"	OK
IF A%*5>=10000 THEN STOP	Program STOPs
IF A% PRINT "YES"	YES (Non zero is True)
PRINT 50>50	0
PRINT 50>=50	-1
IF A%>30000 THEN PRINT "OK"	Nothing
X=1: IF X THEN PRINT "YEP"	YEP
X=0: IF X THEN PRINT "YEP"	Nothing
X=77.321>77.320+1	0
X= "HELLO"="HELLO"	X=-1
IF A$="HELLO" PRINT "YES"	YES
IF A$="HELLLO" PRINT "YES"	Nothing
IF A$>"HEL" THEN PRINT A$	HELLO
IF A$<>"GOON" THEN PRINT "NO"	NO
IF STR$(A%)=" 2000" PRINT "YES"	YES

MATH

LOGICAL OPERATORS

Zbasic makes use of the logical operators AND, OR, NOT, SHIFTS and XOR. These operators are used for comparing two 16 bit conditions and binary operations (except on 32 bit computers which can compare 32 bits). When used in comparative operations a negative one (-1) is returned for TRUE, and a zero (0) is returned for FALSE.

Logical Operators	**RETURNS**
condition **AND** condition	TRUE(-1) if both conditions TRUE, else FALSE(0)
condition **OR** condition	TRUE(-1) if either or both is TRUE, else FALSE(0)
condition **XOR** condition	TRUE(-1) if only one condition is TRUE, else FALSE(0)
condition **SHIFT** condition	TRUE(-1) if any non-zero value returned, else FALSE(0)
NOT condition	TRUE(-1) if condition FALSE, else FALSE(0) if TRUE

EQV (emulate with)
NOT (condition XOR condition) TRUE(-1) if both conditions FALSE or both conditions TRUE, else FALSE(0)

IMP (emulate with)
(NOT condition) OR condition FALSE(0) if first condition TRUE and second condition FALSE, else TRUE(-1)

AND **BOOLEAN "16 BIT" LOGIC**

```
1 AND 1 = 1                     00000001              00000111
0 AND 1 = 0              AND    00001111       AND    00001111
1 AND 0 = 0              =      00000001       =      00000111
0 AND 0 = 0
```

OR

```
1 OR 1 = 1               00000001              10000101
0 OR 1 = 1        OR     00001111       OR     10000111
1 OR 0 = 1        =      00001111       =      10000111
0 OR 0 = 0
```

XOR

```
1 XOR 1 = 0                     00000001              10000101
0 XOR 1 = 1              XOR    00001111       OR     10000111
1 OR 0 = 1        =      00001110       =      00000010
0 XOR 0 = 0
```

SHIFT >>, <<

```
255 >> 2 = 63                   11111111              00010111
23 << 3 =184             >>     00000010       <<     00000011
                  =      00111111       =      10111000
```

NOT

```
NOT 1 = 0         NOT    11001100       NOT    01111011
NOT 0 = 1         =      00110011       =      10000100
```

With the Macintosh, 32 bit integers may also be used with logical operators (LongInteger&).

NUMERIC CONVERSIONS

INTEGER BASE and SIGN CONVERSIONS

ZBasic has functions for converting integer constants to hexadecimal (BASE 16), octal (BASE 8), binary (BASE 2), unsigned integer and back to decimal (BASE 10).
UNS$, HEX$, OCT$ and BIN$ are the functions used to convert an integer to the string representation of that SIGN or BASE.

DECIMAL TO BASE CONVERSION

HEX	**OCTAL**	**BINARY**
HEX$(48964) ="BF44"	OCT$(54386) ="152162"	BIN$(255) ="0000000011111111"
HEX$(32) ="0020"	OCT$(8) ="000010"	BIN$(512) ="0000000100000000"

BASE TO DECIMAL CONVERSION

HEX	**OCTAL**	**BINARY**
VAL("&0030") =48	VAL("&O000011") =9	VAL("&X0000000001100011") = 99

DISPLAYING UNSIGNED INTEGERS

To display or print an unsigned integer number use UNS$. UNS$ returns the unsigned value of the number by not using the leftmost bit as a sign indicator:
UNS$(-1)=65,535, UNS$(-2311)=63,225

ZBasic interprets the integers, -1 and 65,535 as the same value. In BINARY format they are both 1111111111111111. The left-most bit sets the sign of the number to positive or negative. This is the same unsigned integer format used by many other languages.

The same holds true with LongIntegers, only 32 bits are used instead of 16 bits. The signed range is +- 2,147,483,647. The unsigned range is 0 to 4,294,967,293. See DEFSTR LONG in the appendix for ways of using 32 bit HEX$, OCT$, UNS$ and BIN$.

NUMERIC CONVERSIONS

CONVERSION BETWEEN DIFFERENT VARIABLE TYPES

ZBasic will convert variables from one type to another as long as the conversion is within the range of the target variable.

DOUBLE or SINGLE PRECISION VARIABLE =INTEGER VARIABLE will convert exactly (unless single precision is set less then 6 digits).

INTEGER VARIABLE=DOUBLE or SINGLE PRECISION VARIABLE will convert correctly if the double or single precision variables are within the integer range of -32,768 to 32,767 (unsigned 0 to 65,535). Any fractional part of the number will be truncated. Results outside integer range will be the rounded integer result, which is incorrect, and no error will be generated.

SINGLE PRECISION VARIABLE=DOUBLE PRECISION VARIABLE conversions will be exact to the number of significant digits set for single precision since the calculations are done in double precision. If the single precision default is 6 digits and double precision is 14 digits, the 14 digit number would be rounded down to 6 digits in this example (precision is configurable by the user).

STRING VARIABLE=STR$(INTEGER, DOUBLE OR SINGLE PRECISION VARIABLE) will convert exactly. The first character of the string produced is used for holding the sign. If the number is positive or zero, the first character of the string produced will be a SPACE, otherwise the first character of the string will be a minus (-).

INTEGER VARIABLE=VAL(STRING VARIABLE) will convert correctly, up to the first non-numeric character, if the string variable represents a number in integer range. Fractional portions will be ignored. Zero will be returned if not convertible.

DOUBLE OR SINGLE PRECISION VARIABLE=VAL(STING VARIABLE) will convert correctly within the range of floating point precision set by the user (rounding will occur if it is more digits than the set precision).

LongInteger conversions are the same as regular integers with the exception that the range is much larger. Since all internal integer calculations are done in LongInteger, conversions are simple. See DEFSTR LONG in the Macintosh appendix.

CONSTANTS

CONSTANTS

Constants are values used in expressions, variable assignments, or conditionals. In the following underlined program lines, the constants values remain constant, while values of A$, Z and T are variable.

```
10 PRINT"HELLO THERE":  PRINT A$:   Z=Z+T+2322.12
```

ZBasic users both string (alphanumeric) and numeric constants.

INTEGER CONSTANTS

An integer constant is in the range of -32,768 to 32,767 (or unsigned integer in the range of 0 to 65,535).

The BASE of an integer may be represented in Decimal, Hexadecimal, Octal or Binary. See "Numeric Conversions" for information about converting integers to and from HEX, OCTAL, BINARY and DECIMAL.

MEMORY REQUIRED FOR INTEGER CONSTANTS

Two bytes each in the same format as integer variables.

The Macintosh also has LongInteger constants with a range of +-2,147,483,647. LongInteger constants require four bytes memory each. Macintosh format of integer is the opposite of other versions. i.e. MSB is first and LSB is last.

CONSTANTS

FLOATING POINT CONSTANTS

The range of floating point constants is +-1.0E-64 to +-9.999E+63*. Constants may be expressed in scientific notation and/or up to 54 digits of significant accuracy.

Floating point constants are significant up to the double precision accuracy set by the user. If the number of digits is greater than the accuracy of double precision, it will be rounded to that precision. If the double precision default of 14 digits is assumed, a constant of 1234567890.123456 will be rounded to 1234567890.12345.

Constants may be forced as double or single precision by including a decimal point in the constant or by using # for double precision or ! for single precision.

MEMORY REQUIRED FOR FLOATING POINT CONSTANTS

ZBasic will store floating point constants in Binary Coded Decimal format (See Floating point variables memory requirements). This is based on the actual memory requirement of each constant, with a minimum memory requirement of 3 bytes per constant. To calculate the memory requirements of a specific constant use the formula:

NUMBER of DIGITS in the constant/2+1=Bytes needed*
Minimum of 3 bytes required per Floating point constant.

*the range of Double precision constants is E+-16,383 (single precision remains the same for compatibility). To calculate the memory required use the following equation ; Number of Digits/2+2=bytes needed (single precision is the same as above).

Important Note: Some versions of ZBasic offer an optional high speed binary-floating-point option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

STRING CONSTANTS

String constants are alphanumeric information enclosed in double quotes with the number of characters limited by line length (255 characters maximum).

```
"This is a string of characters"
"12345 etc."
"Hello there Fred"
```

Any character except quotes may be included between the quotes. To include quotes in string constants use CHR$(34). PRINT CHR$(34) ;"HELLO";CHR$(34) would print: "HELLO". To conserve memory when using many string constants see PSTR$.

MEMORY REQUIRED FOR STRING CONSTANTS

One byte plus the number of characters, including spaces, within the string constant. See PSTR$ for ways of conserving memory with string constants.

VARIABLES

VARIABLES

The word VARIABLE describes the label used to represent alterable values. ZBasic differentiates between four types of variables.

VARIABLE TYPE	TYPE OF STORAGE	RANGE
STRING	ALPHANUMERIC	0 TO 255 CHARACTERS
INTEGER	INTEGER NUMBERS	+-32,767
SINGLE PRECISION	FLOATING POINT NUMBERS	E+- 63
DOUBLE PRECISION	FLOATING POINT NUMBERS	E+- 63

In addition to the variable types described above this version also supports LongInteger and an extended double precision range (single precision is the same as above).

LONG INTEGER	FOUR BYTE INTEGER	+-2,147,483,647
DOUBLE PRECISION	FLOATING POINT NUMBERS	E+-16,383

Important Note: Some versions of ZBasic offer an optional high speed binary-floating-point-option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

VARIABLE TYPE DECLARATION

Variable names may be followed by a type symbol:

$	STRING VARIABLE
%	INTEGER VARIABLE
!	SINGLE PRECISION VARIABLE
#	DOUBLE PRECISION VARIABLE

If type is not given, integer is assumed (unless configured differently). A, A!, A$, A#, A(2,2), A#(2,2), A!(2,2) and A$(2,2) are considered different variables. Note: A and A% are the same variable if ZBasic is configured to Integer.

Type declaration for LongInteger is; **&**

VARIABLES

DEFINING VARIABLE TYPES

If you want to define variables beginning with a specific letter to be a specific type, use the DEF statement at the beginning of a program.

DEFSTR A-M,Z — Defines all variables starting with A thru M and Z as string variables. M and M$ are the same variable.

DEFSNG A-C — Defines all variables starting with A thru C as single precision variables. C and C! are the same variable.

DEFDBL F,W — Defines all variables starting with F and W as Double precision variables. F and F# are the same.

DEFINT A,G,T-W — Defines all variables starting with A,G and T thru W as integer variables. No % needed. A and A% are considered the same variable.

Note: Even if a range of letters is defined as a certain type, a declaration symbol will still force it to be that type. For instance, if A-Z are defined as integer using DEFINT, A$ is still considered a string, and A# is still considered a double precision variable.

DEFDBL INT A-M Defines variables starting with A thru M as LongIntegers. No & needed. A and A& are the same variable.

VARIABLE NAMES

Variable names must have the following characteristics:

o Variable names may be up to 240 characters in length but only the first 15 characters are recognized as a unique variable.
o First character must be in the alpha range of A-Z, or a-z.
o Additional characters are optional and may be alphanumeric or underline.
o Symbols not allowed: ",^/+->=<][()? etc.

SPACE REQUIRED AFTER KEYWORDS

Many versions of ZBasic have this as a configure option. See "Configure". If you don’t want to worry about embedding keywords in variables, set "Space Required after Keywords" option to "yes". It will require that keywords be followed by spaces or non-variable symbols. This allows variable names like FORD or TOM.

If you do not set this parameter, or do not have this option for your version of ZBasic, you must not embed keywords in variables.

UPPER/LOWERCASE WITH VARIABLES

If you want the variable TOM and the variable tom to be the same variable, you must configure "Convert to Uppercase" to "yes". See "Configure".

If you do not set this parameter, or do not have this option for your version of ZBasic, you must match case when using variables. i.e. TOM and tom are different variables.

MEMORY REQUIRED FOR VARIABLES

VARIABLES	MEMORY REQUIRED
INTEGER %	2 bytes
STRING $	256 bytes (default). String variable length is definable from 1 to 255 characters (plus one for length byte).
SINGLE PRECISION !	4 bytes (default)
DOUBLE PRECISION #	8 bytes (default) If Single or Double precision digits of precision is changed, use this equation to calculate memory requirements: DIGITS of ACCURACY /2+1=BYTES REQUIRED*

ARRAY VARIABLES

ARRAY VARIABLES	MEMORY REQUIRED PER ELEMENT
INTEGER %	2 bytes per element
STRING $	256 bytes (default) per element. String variable length is definable from 1 to 255 characters per element. Add one byte per element to the defined length of the string for the length byte. DEFLEN 200=201 bytes required per element.
INDEX$(element)	1 byte plus the number of characters in an element
SINGLE PRECISION !	4 bytes (default) per element
DOUBLE PRECISION #	8 bytes (default) per element If FLOATING POINT digits of precision are changed, use this equation to calculate memory requirements: NUMBER OF DIGITS/2+1=BYTES REQUIRED*

Note: Remember to count the zero element if BASE zero is used.

Important Note: Some versions of ZBasic offer a high speed binary-floating-point option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

*LongInteger variables and arrays use four bytes each. To determine double precision memory requirements for the Macintosh version: DIGITS/2+2=BYTES REQUIRED per variable or per double precision array element.

VARIABLES

INTEGER VARIABLES

Because ZBasic always attempts to optimize execution size and speed, it will always assume a variable is integer unless the variable is followed by a type declaration (#, !, $, &) or that range of letters has been defined DEFSTR, DEFDBL, DEFDBL INT or DEFSTR. Although it will slow down program performance, you may force ZBasic to assume floating point variables under configuration. See "Configure". **Integer calculations may be 100 to 200 times faster than floating point!**

INTEGER RANGE

-32,768 to +32767

LongInteger range is +-2,147,483,647. Speed is as fast as regular integers.

DEFINING VARIABLES AS INTEGER

ZBasic assumes all unDEFined variables, or variables without type declarations (#,!,$,&), are integer (unless configured differently by the user).

DEFINT may be used to force a range of variables starting with a certain letter to be integer with the DEFINT statement followed by a list of characters. For example: DEFINT A-G defines all variables starting with A,B,C...G to be integer. (G and G% would be the same in this case.)

To force a specific variable to be integer, even if that letter type has been DEF(ined) differently, follow a variable with %. TEST%, A% and F9% are integer variables.

INTEGER OVERFLOW RESULTS

If a program calculation in an integer expression exceeds the range of an integer number, ZBasic will return the overflowed integer remainder of that calculation. The result will be incorrect. **ZBasic does not return an Integer Overflow Error**. Check program logic to insure results of an operation remain within integer range.

HOW INTEGER VARIABLES ARE STORED IN MEMORY

Integer variables and integer array elements require two bytes* of memory. To find the address (location in memory) of an integer variable:

ADDRESS^{1} = VARPTR(**INTEGER VARIABLE**[(SUBSCRIPT[,SUBSCRIPT[,Ö.])])
ADDRESS^{2} = ADDRESS^{1} +1

The value of **INTEGER VARIABLE** is calculated using this equation:

INTEGER VARIABLE=VALUE OF ADDRESS^{2}***256 + VALUE OF ADDRESS**^{1}

*Requires four bytes for LongInteger. The MSB and LSB are stored in reverse order with regular integers. See the Macintosh appendix for more information.

FLOATING POINT (BCD) VARIABLES

There are three floating point precisions that may be configured by the programmer to return accuracy up to 54 significant digits:

ZBasic does all BCD calculations in DOUBLE PRECISION. This is extremely important when speed is a factor. If you only need 6 or 7 digits of precision and speed is important be sure to CONFIGURE DIGITS OF ACCURACY AS FOLLOWS:

DOUBLE PRECISION	**= 6**
SINGLE PRECISION	**= 4**
SCIENTIFIC PRECISION	**= 4**

This setting will give you maximum speed in BCD floating point. See the appendix for your computer for variations or enhancements. This is not a factor for the optional binary math package available for some version of ZBasic.

The Macintosh accuracy can be configured up to 240 digits. Optimum BCD speed is realized by configuring double precision to 8, single and scientific precision to 6.

Important Note: Some versions of ZBasic offer an optional high speed binary-floating-point option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

DEFINING VARIABLES AS SINGLE OR DOUBLE PRECISION

To force the precision of a specific variable to be single precision, follow every occurrence of that variable with an exclamation point (!).

To force a variable to be double precision, follow the variable name with a pound sign (#). To force ZBasic to define a range of variables as double or single precision, use the DEFDBL or DEFSNG statement:

DEFDBL A-G — Makes all variables beginning with A-G as Double precision.
A# and A would be the same variable in this case.

DEFSNG C — Makes all variables beginning with C as Single precision.
C! and C would be the same variable.

Note: Some versions of BASIC default to single precision variables instead of integer. Use DEFSNG A-Z in programs being converted or configure to assume Floating Point. Also see "Optimize Expression Evaluation as Integer" under "Configure".

VARIABLES

SCIENTIFIC - EXPONENTIAL NOTATION

ZBasic expresses large numbers like:

```
           50,000,000,000
like this: 5E+10 or 5E10
```

The plus sign (+) after the "E" indicates the decimal point moves to the right of the number. Ten places in this example.
Technically: 5*10*10*10*10*10*10*10*10*10*10 or 5*10^10.

ZBasic expresses very small numbers like:

```
           .000005
like this: 5E-06
```

A minus sign after the "E" indicates the decimal point is moved to the left of the number that many places, six in this example. Technically: 5/10/10/10/10/10/10 or 5*10^(-6).

STANDARD NOTATION	SCIENTIFIC NOTATION
9,123,000,000,000,000	9.123E+15 (or E15)
-3,400,002,000,000,000,000	-3.400002E18 (or E+18)
.000,000,000,000,000,000,011	1.1E-20
-.000,012	-1.2E-05

Note: Some BASICs use scientific notation with a "D" instead of an "E". (like 4.23D+12 instead of 4.23E+12) ZBasic will read old format values correctly but will use the more common "E" when printing scientific notation.

WHEN SCIENTIFIC NOTATION IS EXPRESSED

Constants and variables will be expressed in scientific notation when the value is less than .01 or exceeds 10 digits to the left of the decimal point.

You can force ZBasic to print all significant digits in regular notation with: **PRINT USING**

See **PRINT USING** in the Reference Section of this manual.

RANGE OF ZBASIC FLOATING POINT VARIABLES

The range of floating point numbers, regardless of the accuracy configured is:

+-1E-64 to +-9.9E+63.*

The digits of accuracy are 14 digits for double and 6 digits for single (this is the default for most systems and may be set by the user).

Double Precision exponent may range from E-16,384 to E+16,383. Single Precision exponent is the same for compatibility with 8 and 16 bit machines.

VARIABLES

OVERFLOW RESULTS

If an expression results in a number greater then +-9.999E+63, a result of 9.999E+63 will be returned.

If the number is less then +-1.0E-64 the result will be zero. ***ZBasic will not give an overflow or underflow error***. Check program logic so that numbers do not exceed floating point range.

BCD FLOATING POINT SPEED

To obtain maximum speed out of BCD floating point math be sure to configure the digits of accuracy to:

DOUBLE PRECISION = 6
SINGLE PRECISION = 4
SCIENTIFIC PRECISION = 4

Normally these settings are fine at 14 and 6 digits. The should only be changed when speed is extremely important. Converting equations to integer will greatly increase speed as well. These settings are important because ZBasic does all calculations in Double precision. Single precision is used for saving memory only.

Important Note: Some versions of ZBasic offer an optional high speed binary-floating-point option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

SINGLE AND DOUBLE PRECISION DIGITS OF ACCURACY

The only difference between Single and Double Precision is that Single Precision holds fewer significant digits than Double Precision. ***ALL ZBASIC FLOATING POINT CALCULATIONS ARE PERFORMED IN DOUBLE PRECISION***.

The default digits of accuracy are 6 digits for Single Precision and 14 digits for Double Precision. The accuracy is configurable from 6 to 54 digits for Double and 2 to 52 digits for Single Precision.*

ACTUAL	SINGLE	DOUBLE
NUMBER	PRECISION*	PRECISION*
12,000,023	12000000	120000023
.009,235,897,4	9.2359E-03	9.2358974E-03
988,888	988,888	988,888
.235,023,912,323,436,129	.235024	.23502391232344
9,999,999 .999,900,001,51	10000000	9999999.9999
88.000,000,912,001,51	88	88.000000912002
12.34147	12.3415	12.34147

*Defaults are 8 and 12 digits for the Macintosh. Both are configurable up to 240 digits.

ROUNDING

If the digit just to the right of the least significant digit is greater than 5, it will round up, adding one to the least significant digit.

In the example for **`.009,235,898,4`** above, the last significant 6 digit number is nine, but since the digit after 9 is 7, the 9 is rounded up by one to 10 (and subsequently the 8 is rounded up to 9 to give us 9.2359E-03, which more accurately represents the single precision value. See "Configure" for ways of setting the rounding factor.

NUMBER	DEFAULT ROUNDING FACTOR IS: 49	
####49	.49+.49 = .98 which is less than one	No Rounding
####50	.50+.49 = .99 which is less than one	No Rounding
####51	.51+.49 = 1 which is equal to one	Rounds up
####52	.52+.49 = 1.1 which is greater than one	Rounds up

This rounding option will not be available for optional binary floating point packages.

CONFIGURING ACCURACY

ZBasic allows the user to configure the digits of accuracy for single, double or scientific precision functions (like LOG, TAN, SIN, etc.)

LIMITATIONS:
Double precision must be at least 2 digits more significant than single.
Digits of Accuracy must be in multiples of two (four with Macintosh).

TYPE	MINIMUM DIGITS	MAXIMUM DIGITS
PRECISION	OF ACCURACY	OF ACCURACY*
SINGLE	2 DIGITS	2 DIGITS less than Dbl.
DOUBLE	6 DIGITS	54 DIGITS
SCIENTIFIC	2 DIGITS	54 DIGITS

*Note: **All floating point calculations are done in DOUBLE PRECISION**. For programs where floating point speed is important be sure to set the digits of accuracy to:

```
DOUBLE PRECISION      = 6
SINGLE PRECISION      = 4
SCIENTIFIC PRECISION  = 4
```

Important Note: Some versions of ZBasic offer an optional high speed binary-floating-point option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

WARNING: Programs sharing disk files and CHAINED programs with single or double precision variables must have the same accuracy configuration. If one program is set for 6 and 14 digits, and another program is set for 10 and 20 digits, the programs will not be able to read and write each others files.

Configurable up to 240 digits. For hi-speed set Double to 8, single and scientific to 6.

ACCURACY AND MEMORY REQUIREMENTS

The number of bytes of memory or disk space required for storing single and double precision variables is dependent on the digits of accuracy. If you do not change the accuracy, ZBasic will assume 6 digits for single precision (which requires 4 bytes), and 14 digits for double precision (which requires 8 bytes).*

When you change accuracy, disk files, variables, and constants memory requirements will change as well. The equation to calculate memory or disk file space required for single or double precision variables is:

Digits of Accuracy / 2+1=Bytes required per Floating Point variable

DIGITS of ACCURACY	DISK FILE AND VARIABLE MEMORY REQUIREMENTS
2 digits	2 bytes
4 digits	3 bytes
5 digits	Will round odd digits UP to the next even number, 6 here
6 digits	4 bytes (Single precision default if not configured by user)
.	
.	
.	
14 digits	8 bytes (Double precision default if not configured by user)
.	
.	
.	
52 digits	27 bytes
54 digits	28 bytes

*The Macintosh defaults to 8 digits for single (four bytes) and 12 digits for double (eight bytes). Digits of accuracy are configurable in multiples of four (instead of two as above). To figure memory: Digits of Accuracy/2+2=bytes required.

WARNING: Different ZBasic programs sharing files and CHAINED programs MUST be set to the same accuracy. Failure to do this will result in program errors, faulty data reads or program crashes.

Important Note: Some versions of ZBasic offer an optional high speed binary-floating-point option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

VARIABLES

HOW BCD FLOATING POINT VARIABLES ARE STORED IN MEMORY

Single precision default is 6 digits (4 bytes). Double precision default is 14 digits (8 bytes). To locate the address (memory location) of either a Single or Double precision variable:

ADDRESS^{1}=VARPTR(FLOATING POINT VARIABLE [(SUBSCRIPT[,SUBSCRIPT[,...])])

Single and Double precision variables are stored in Binary Coded Decimal format (BCD).

```
                  Bit   7 6 5 ... 0
*ADDRESS1=              . . . . . . . .
              Bit 7:    Mantissa sign (0=POSITIVE, 1=NEGATIVE)
              Bit 6:    The exponent sign (0-E+, 1=E-)
              Bit 5-0:  The exponent value (0 to 64)
ADDRESS2                Digit 1  and 2 (Four bits for each digit)
ADDRESS3                Digit 3  and 4
ADDRESS4                Digit 5  and 6 (Single precision default)
ADDRESS5                Digit 7  and 8
ADDRESS6                Digit 9  and 10
ADDRESS7                Digit 11  and 12
ADDRESS8                Digit 13  and 14 (Double precision default)
.
.
ADDRESS28               Digit 53 and 54 (Limit of significant digits)
```

*Single precision defaults to 4 bytes (six digits) and Double precision defaults to 8 bytes (12 digits). Macintosh computers use two bytes for mantissa and exponent for its high precision double precision variable type:

```
ADDRESS1 & 2      Bit     15 14 13 ... 0
                          ...............
          Bit 15:         Mantissa sign
          Bit 14:         Exponent sign
          Bit 13-0        Exponent value 0-16383
```

Range of 32 bit double precision is +-1.0E-16,383 to +-9.999E+16,384

Note: Single precision range is the same on all machines.

Important Note: Some versions of ZBasic offer an optional high speed binary-floating-point option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

ACCURACY VERSUS PROCESSING SPEED

While ZBasic is capable of configuration to extremely high accuracy, you should be aware that calculation time is in direct relation to the number of digits of accuracy.

The following chart will clarify the relationship of processing time to accuracy.

ACCURACY versus PERFORMANCE

Math	**Relative**	**|----------**		**Digits of Accuracy**			**---------**	
|Function	**Speed**	**4/6***	**6/6***	**14**	**24**	**36**	**54**	**INTEGER**
Add/Subtract	1		2/3	1	1.20	1.50	2.0	1/77
Multiply	3		1/7	1	1.25	3.10	5.8	1/33
Divide	12		1/6	1	1.25	1.75	3.0	1/33
SQR	50	1/5	1/4	1	2.50	5.75	13.0	
SIN	70	1/5	1/4	1	2.50	5.75	13.0	See USR8(0)
COS	70	1/5	1/4	1	2.50	5.75	13.0	See USR9(0)
TAN	150	1/5	1/4	1	2.50	5.75	13.0	
EXP	100	1/5	1/4	1	2.50	5.75	13.0	
LOG	65	1/5	1/4	1	2.50	5.75	13.0	
ATN	80	1/5	1/4	1	2.50	5.75	13.0	
X^n	140	1/5	1/4	1	2.50	5.75	13.0	
X^(integer)	30		1/2	1	1.67	2.75	5.0	
Shift <<,>>	2		3/4	1	1.25	1.75	2.2	1/20

EXPLANATIONS OF HEADINGS

Math Function The type of math function being timed.

Relative Speed All speeds are relative to ADD and SUBTRACT (SQR takes 50 times longer than add and subtract). The numbers also correspond to the approximate time (in milliseconds) it takes to perform 14 digit math on a Z80 at 4 MHZ.

Digits of accuracy The numbers under the digits are all relative to 14 digit accuracy. Examples: 54 digit divide takes 3 times longer than 14 digit
6 digit divide takes 1/7th the time of 14 digit multiply.

INTEGER Integer calculations are relative to 14 digit processing time. Integer add and subtract operations take 1/77th the time of 14 digit operations.

***4/6** Scientific Accuracy operations were set for LOG, TAN, EXP, ^, SIN, COS and ATN only. Other functions remain at double precision.

SPEED To obtain maximum speed with BCD floating point calculations, configure the digits of precision to : DOUBLE PRECISION=6, SINGLE PRECISION=4, SCIENTIFIC PRECISION=4. ZBasic does ALL calculations in DOUBLE PRECISION.

Important Note: Some versions of ZBasic offer an optional high speed binary-floating-point option. While the speed of binary math packages is superior, the accuracy, range and memory requirements of binary math are much different from the standard BCD math described above. See the manual provided with the binary math package for details.

VARIABLES

STRING VARIABLES

String variables are used for storing alphanumeric, symbol, and control characters.

ZBasic string variables may hold up to a maximum of 255 characters. Any character with an ASCII code in the range of zero to 255 may be used. ASC(A$) will return zero if A$ is a null string: IF LEN(A$)>0 AND ASC(A$)= 0 THEN ASCII CODE=0

STRING, NUMBER CONVERSIONS

VAL	Converts a string to a number: X=VAL(A$)
STR$	Converts a number to a string: A$=STR$(43)
CVI, CVB	Converts a condensed string to a number
MKI$, MKB$	Converts numbers to condensed strings.

See DEFSTR LONG for using CVI and MKI$ with LongIntegers

DEFINING STRING VARIABLES

Use a $ symbol following a variable name to make it a string variable. A$ will always be a string variable because of the $.

To define a range of variables beginning with a certain character to be string variables (so you do not have to use $ every time), use the statement DEFSTR:

DEFSTR A-M	Makes all variables starting with A, B, C. up to M as string variables. A is the same as A$
DEFSTR X,Y,Z	Makes all variables starting with X,Y and Z as string variables. Z is the same as Z$.

STRING VARIABLE ASSIGNMENTS

String variables are assigned alphanumeric values like this:

```
A$="Hello there"
ART$="VanGogh"+" DaVinci"        (+) connects the strings (concatenates)
Z$=B$
Z$=B$+C$
Z$="Hello"+C$+TEST$
MID$(A$,2,3)="YES"               Puts "YES" into A$ starting at position 2
```

STRING FUNCTIONS AND RELATED COMMANDS

String variables are used for storing and manipulating character information. Here are some examples of ZBasic's string capabilities:

STRING FUNCTIONS	DEFINITION
DIM 10 A$	sets the string variable A$ to a length of ten.
DEF LEN 20	Sets the following strings to 20 character length.
W$=LEFT$(A$,3)	W$= 3 characters from the left of A$.
W$=RIGHT$(A$,1)	W$= 1 character from the right of A$.
B$=MID$(A$,4,2)	B$=2 characters from A$ beginning at position 4.
MID$(A$,2,3)=B$	Puts first 3 characters of B$ into A$ starting at position 2.
C$=CHR$(65)	C$= the character represented by ASCII 65 (letter A).
X=ASC("A")	X= the ASCII code of "A" (65).
X=INSTR(2,A$,B$)	Looks for B$ in A$ starting at position 2, and makes X equal to the position if found, otherwise X=zero.
A$=STR$(2345)	Makes A$ equal "2345"
X=VAL(A$)	Makes X equal the VALue of A$ (2345 if above).
X=LEN(A$)	X= the number of characters in A$.
INPUTA$	Gets input from the keyboard and stores it in A$.
LINEINPUTA$	Accepts any keyboard characters, stores them in A$ and terminates input only with the <ENTER> key.
A$=INKEY$	Makes A$= the last key pressed without using <ENTER>
A$=UCASE$("Hello")	Converts A$ to UPPERCASE. (A$ now equals "HELLO").
X=VARPTR(A$)	X= the memory address of the variable A$.
WRITE#1,A$;20	Writes 20 characters of A$ out to the disk file#1.
READ#1,A$;20	Reads 20 characters off the disk into A$.
A$=STRING$(10,"#")	Makes A$ equal to "##########".
PRINT SPACE$(4)	PRINTs 4 spaces.
SWAP A$,B$	Make A$ equal B$ and B$ equal A$.
LPRINTA$	Prints A$ out to the printer.
PRINT A$	Prints A$ to the screen.
PRINT #2,A$	Prints A$ to disk file 2.
OPEN"R",1,F$,129	Opens the random access file named F$.
KILL A$	Erases the file specified by A$ off the storage device.
A$=DATE$	Puts the date into A$ (MM/DD/YY) (Most systems).
A$=TIME$	Puts the time into A$ (HH/MM/SS) (Most systems).
A$=B$+C$	Makes A$ equal to B$ plus C$ (Concatenates).
A$="HI"+"THERE"	Makes A$ equal to "HI THERE".
PSTR$	Special command to avoid duplication of string constants.

SPECIAL INDEX$ COMMANDS

INDEX$ (n)="simple string"	INDEX$="Simple string"
INDEX$I (n)=A$	INSERT A$ at INDEX$(n), moves up all other elements.
INDEX$D(n)	DELETE element (n) of INDEX$ and move up other elements.
X=INDEXF(A$)	Looks for A$ in INDEX$ (all) X equals element if A$ found. Else equals -1.
X=INDEXF("END",950)	Look for "END" in INDEX$ starting at the 950th element.
CLEAR nnnnn	Set aside nnnnn bytes for INDEX$.
CLEAR INDEX$	Nullify the contents of the entire INDEX$ array.

STRING CONDITIONALS

Strings may be compared using conditional operators just like numbers. The difference is that they are compared by the value of the ASCII code for that number. For instance, the ASCII code for "A" is 65 and "B" is 66. Therefore the expression "A"<"B" would be true (-1).

See ASCII Chart in your computer manual. ASCII characters may vary from computer to computer and from printer to printer.

Be aware that ZBasic differentiates between upper and lowercase characters. "a" is greater than "A" because the ASCII code for "a" is 97 and the ASCII code for "A" is 65. If you want ZBasic to look at a string variable as uppercase only, use the UCASE$ function to convert it.

ZBasic "looks" at all the characters in a string when doing comparisons. "Aa" is greater than "AA". "AAAAAAa" is greater than "AAAAAAAA" etc. ZBasic will compare characters in a string to the last character in that string.

CONDITION	RESULT
"RRRRR"<"S"	True (-1)
"FRANK"="FRANK"	True (-1)
"abc">"ABC"	True (-1)
TEST$="Hello"(If TEST$="Hello")	True (-1)
"A">"B"	False (0)
"YES"="yes"	False (0)

SIMPLE STRINGS

Quoted string: "Hello", "This is within quotes"
String variable: A$, NAME$, FF$, BF$(2,3)
Any of the following string commands: MKI$, MKB$, CHR$, HEX$, OCT$, BIN$, UNS$, STR$, ERRMSG$, TIME$, DATE$, INKEY$, INDEX(n)

COMPLEX STRINGS

May be any combination of SIMPLE STRINGS.

String operations containing one of the following commands: simple- string + simplestring. LEFT$, RIGHT$, MID$, STRING$, SPACE$, UCASE$ would be a complex string.

COMPLEX STRINGS MAY NOT BE USED WITH IF-THEN STATEMENTS.

ZBasic allows only one COMPLEX STRING per statement. If you wish to perform more than one complex sting at a time, simply divide the complex string expression into multiple statements like this:

CHANGE complex strings	**TO** simple strings
B$=RIGHT$(A$+C$,2)	B$=A$+C$: B$=RIGHT$(B$,2)
B$=UCASE$(LEFT$(A$,3))	B$=LEFT$(A$,3): B$=UCASE$(B$)
IF LEFT$(B$,2)="IT" THEN 99	D$=LEFT$(B$,2): IFD$="IT" THEN 99

USING STRING VARIABLES EFFICIENTLY

String variables will require 256 bytes of memory for each string used if the string lengths are not defined by the user. It is important to realize that extensive use of string variables or string array variables may require the user to define string lengths to avoid running out of memory.

Note: Some BASIC(s) have what is referred to as "Garbage collection". ZBasic's method of storing strings NEVER creates time wasting "Garbage Collection".

DEFINING THE LENGTH OF STRING VARIABLES

ZBasic strings have a default length of 255 characters. This can cause excessive memory usage. To obtain maximum memory efficiency, there are two ways of defining the length of string variables and string array variables:

DEF LEN = *number* (Numbers only. *No expressions*.)
DIM *number STRING VARIABLE, or number STRING ARRAY*, …

DEFINING STRING LENGTHS WITH DIM

```
DIM X$(10), 20 A$, Z$(5), 45 TEST$, 10 MD$(20,20)
```

In this example the strings are allocated:

X$(10)	255 each element (255 is the default. 2816 bytes)
A$	20 (21 bytes)
Z$(5)	each element of Z$ as 20* (21*6=105 total bytes of memory used.)
TEST$	45 (46 bytes)
MD$(20, 20)	each element of MD$(20,20) as 10. (21 * 21 *11=4851 total bytes of memory used.)

* If no length is defined, the last given length in that DIM statement is used (20 for A$ in this example). If no length was defined in that DIM statement then the DEFined LENgth is assumed (255 if the string length has not been previously defined)

Note: Add one to the defined length of each string to determine the actual memory requirement of the string PLUS ONE for the LENGTH BYTE.

DEFINING STRING LENGTHS WITH DEFLEN

Another command for DEF(ining) the LEN(gth) of string variables is:

DEF LEN = NUMBER (No expressions)
(In the range of 1 to 255)

Each string variable located AFTER the statement will have that length, unless another DEFLEN or DIM statement is used.

```
DIM A$(9,9), X(99),  H#(999), 4Bull$
DEF LEN=50:B$="HOPE"
C$="HELLO"
DEF LEN=100
ART$="COOL"
DIM Coolness$(9)
A$=ART$
```

In the example:

A$(9,9)	allocated 255 characters for each array element (ZBasic automatically allocates 255 if length has not been defined).
Bull$	allocated 4 characters.
B$** and **C$	allocated 50 characters each.
ART$	allocated 100 characters
Coolness$	allocated 100 characters for each element.
A$	allocated 100 characters.

Note: The actual memory required for each string (each string element in an array) is the defined length plus one byte for the length byte.

HOW STRING VARIABLES ARE STORED IN MEMORY

ADDRESS=VARPTR(**STRING VARIABLE**[(SUBSCRIPT[,SUBSCRIPT[,Ö.])])

ADDRESS	Length Byte: Holds number of characters in the string.
ADDRESS+1	First character of the string variable
ADDRESS+2	Second character
.	
.	
.	
ADDRESS+n	Last character of the string variable
ADDRESS+255	Last address available for undefined string variable
ADDRESS+Defined Length	Last address available for defined string variable

WARNING 1: Strings should never be assigned a character length longer than the assigned length. If the length of A$ is 5 and a program line is executed that has: A$="1234567890", the characters "6" through "0" will overwrite the variables following A$, possibly causing system errors or faulty data.

WARNING 2: If using INPUT to input strings with set length, always make sure the string length is at least one longer than the length being used for input.

For most versions of ZBasic, no error is generated if string assignments exceed the length of the string.

See "Configure" in the Macintosh appendix for setting string length error checking.

INDEX$

INDEX$

SPECIAL INDEX$ STRING ARRAY

INDEX$ is a special ZBasic string array with some powerful and unique capabilities.

The following commands work with INDEX$ variables only.

INDEX$ COMMAND	MEANING
INDEX$(n)=simple string	Assigns a value to INDEX$(n)
INDEX$ I(n)=simple string	Move element n and all consecutive elements up one and **INSERT** simple string at element n (the value in element 3 moves up to element 4). Actually inserts the value into the array without destroying any other elements.
INDEX$ D(n)	**DELETE** element n and move all consecutive elements back down to fill the space (value in element 4 moves down to element 3).
X=INDEXF(simple string [,start#])	**FIND** simplestring in INDEX$. Begin looking at element START#. **If found X=element number** **If not found X = -1.**

USING INDEX$

INDEX$ array variables may be assigned values like other string variables. To illustrate the power of INDEX$, the following values have been stored into INDEX$ elements INDEX$(0) through INDEX$(3) and will be used in the examples on the following pages:

ELEMENT #	DATA
INDEX$(0)=	"AL"
INDEX$(1)=	"BOB"
INDEX$(2)=	"DON"
INDEX$(3)=	"ED"

INDEX$

INSERTING ELEMENTS INTO INDEX$

INDEX$ **I** (n) To INSERT "CHRIS" into INDEX$, between "BOB" and "DON", you would use the command INDEX$ I(2)="CHRIS".

This instructs ZBasic to move "DON" and "ED" down and insert "CHRIS" in element 2. (INDEX$ I(2)=A$ would also be legitimate) INDEX$ would now look like this:

ELEMENT #	**DATA**
INDEX$(0)=	"AL"
INDEX$(1)=	"BOB"
INDEX$(2)=	"CHRIS"
INDEX$(3)=	"DON"
INDEX$(4)=	"ED"

DELETING ELEMENTS FROM INDEX$

INDEX$ **D** (n) To DELETE "BOB" from INDEX$ use the command INDEX$ D(1). This instructs ZBasic to delete element one, and move "CHRIS" and "DON" and all the other elements up to fill in that space. The INDEX$ array would now look like this:

ELEMENT #	**DATA**
INDEX$(0)=	"AL"
INDEX$(0)=	"CHRIS"
INDEX$(0)=	"DON"
INDEX$(0)=	"ED"

FIND A STRING IN INDEX$

X=**INDEXF**(simplestring [,element n])

ZBasic will begin searching from element n (element zero if not specified) for the string specified by simple string. Examples:

IF FOUND	**IF NOT FOUND**
X=ELEMENT NUMBER	X=NEGATIVE ONE(-1)

To FIND "DON" in the above list let's say that A$="DON". Using the command X=INDEXF(A$), X would return 2 to show that "DON" is in element 2 of INDEX$.

To FIND "CHR" (part of "CHRIS"), you would use the command X=INDEXF("CHR"). X would return with the value of 1 since a match was found in the first three characters of "CHRIS".

If you tried to FIND "RIS": X=INDEXF("RIS"), X would return with a value of -1 (negative one) since the FIND command begins the search at the first character of each element, which MUST be significant ("C" must be part of the search).

If the command had been INDEXF("CHRIS", 3), X would have equaled -1 since the search began at element 3 and "CHRIS" is at element 1 it would never find "CHRIS."

INDEX$ MEMORY REQUIREMENTS

INDEX$ variable elements use memory only if there are characters stored in that element and only as much memory as needed to hold those characters (plus one for length byte). CLEAR nnnnn is used to allocate memory for INDEX$. CLEAR INDEX$ will clear (nullify) the present contents of INDEX$.

INDEX$ LIMITATIONS

INDEX$ may not be used with SWAP.

USES OF INDEX$

INDEX$ is a valuable tool for disk indices, in-memory data bases, creating word processors, holding lists of strings with varying lengths and much more.

INDEX$ is especially useful anytime unknown string elements lengths are needed.

USING INDEX$ FOR AN INSERTION SORT

A good example of the power of INDEX$ is using it to create a perpetual sort. It allows you to add items to a list instantly and always have the list in order:

```
CLEAR 10000: TRONB
DO
  INPUT"Input String";A$: GOSUB "INSERTION SORT"
UNTIL A$="END" <--- Type END to end inserting
GOTO "PRINT LIST"
:
"INSERTION SORT"
REM N=Number of items
REM A$= New to string to insert
:
B=N: S=0
DO
  H=(B-S+1)>>1.
  LONG IF A$ <= INDEX$(B-H)
    B=B-H
  XELSE
    S=S+H
  END IF
UNTIL B=S
INDEX$ I(B)=A$
N=N+1
RETURN
:
"PRINT LIST"
FOR X=1 TO N
  PRINT INDEX$(X)
NEXT
END
```

INDEX$

HOW INDEX$ ARRAY VARIABLES ARE STORED IN MEMORY

The INDEX$ array is stored in memory in one contiguous block. The distance between each element is the number of characters in the string plus one byte for the length byte of the string.

WARNING: It is suggested that strings in INDEX$ not be manipulated with PEEK and POKE.

Note: CLEAR is used on some computers to allocate memory for INDEX$. CLEAR INDEX$ is used to nullify the contents of INDEX$.

This version has the ability to use up to ten INDEX$ arrays at the same time. See appendix for details. Also see MEM(-1) for determining memory remaining for INDEX$.

ARRAY VARIABLES

ARRAY VARIABLES

An Array variable is a multi-celled variable followed by coordinates for specifying which cell is to be used. The following is an example of a one dimension string array with 101 elements.

ARRAY ELEMENT	VALUE
NAME$(0)=	"ABE"
NAME$(1)=	"ADAM"
NAME$(2)=	"ALEX"
NAME$(3)=	"AMOS"
.	
.	
.	
NAME$(100)	"ZORRO"

Separate variables could be used for each value, like NAME1$="ABE", NAME2$="ADAM"Ö but typing a hundred different variables would become very tiring.

Array variables are much easier to use when inputting, saving, loading, printing long lists, moving data around in a list, sorting lists of information, etc. This example shows how easy it is to print a complete list of the names in the array of variables.

```
FOR X= 0 TO 100
  PRINT NAMES$(X)
NEXT
```

Computers are very good at manipulating large amounts of data and using regular variables to do this is very impractical.

MULTI-DIMENSIONED ARRAYS

ZBasic will allow arrays of 1,2,3 or more dimensions, depending on the amount of memory available on your computer.

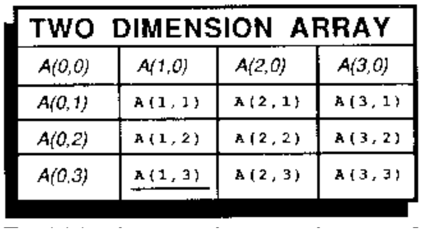
ARRAY VARIABLES

TWO DIMENSION ARRAY EXAMPLE

The following chart shows a two dimensional integer array; A(3,3). The number of elements are determined by the BASE OPTION that was configured when loading ZBasic. The default is Base 0:

A(3,3) BASE 0 dimensions are 4 elements down (0,1,2 and 3) and 4 elements across (0,1,2 and 3). Base zero utilizes all the elements including the italicized.

A(3,3) BASE 1 dimensions are 3 elements down (1,2,3) and 3 elements across (1,2,3) (not the italicized):



TWO DIMENSION ARRAY

A(0,0)	*A(1,0)*	*A(2,0)*	*A(3,0)*
A(0,1)	A(1,1)	A(2,1)	A(3,1)
A(0,2)	A(1,2)	A(2,2)	A(3,2)
A(0,3)	A(1,3)	A(2,3)	A(3,3)

This array was DIM(med) A(3,3). A(1,3) represents the cell underlined above. Accessing a cell only requires giving the correct coordinate after the variable name.

Variables, constants or expressions may be used in specifying coordinates:

A(3,2), A(X,Y), A(2,X), A(X*2/3,2+Y).

BASE OPTION

Zero is considered an element unless you set the BASE OPTION to one when configuring ZBasic. See "Configure" for more information about setting the Base option. The default BASE is zero.

DEFINING THE DIMENSIONS OF AN ARRAY

All variable arrays MUST be **DIM**ensioned at the beginning of a program. When you RUN a program, memory is set aside for the array based on the number of elements you have **DIM**ensioned.

An example of DIM:

```
          DIM A%(10,10,10),  A#(5), A!(9,7), B$(10), 5Cool$(20)
```

Only numbers may be used within DIM statement parentheses. The following DIM expressions are Illegal:

```
DIM A(X),  A(2*X),  A(FR).
```

ARRAY VARIABLES

HOW ARRAYS USE MEMORY

The following chart shows how to calculate the memory requirements of the arrays DIMensioned above with a BASE OPTION of zero (default value).

		Bytes per	How to	Memory
ARRAY	Type	Element	Calculate**	Required
A%(10,10,10)	INTEGER	2	11*11*11*2	2662 Bytes
A#(5)	DOUBLE PREC.	8	6*8	48 Bytes
A!(9,7)	SINGLE PREC.	4	10*8*4	320 Bytes
B$(10)	STRING	256	11*256	2816 Bytes
Cool$(20)	STRING	6	21*6	126

**Note: If you use a BASE OPTION of ONE, you will not need to add one to the dimension. For instance, in the first example the way to calculate the memory required would be: 10*10*10*2. Also see DEF LEN and DIM under STRING VARIABLES for info about defining sting lengths.

Macintosh also has LongInteger arrays. Each element takes 4 bytes.

ARRAY BOUNDS CHECKING

During the initial stages of writing a program, it is a good idea to configure ZBasic to check array bounds in runtime. See "Configure" for more information.

OUT OF MEMORY ERROR FROM DIMMING

It is necessary to have an understanding of how arrays use memory. DIMensioning an array larger than available memory will cause ZBasic to give an OUT OF MEMORY error at Compile time or RUN time. When calculating large arrays be sure to check if memory is sufficient.

ARRAY VARIABLES

PRINTING ARRAYS

Arrays were designed to make manipulating large lists of data easy. The following routines print the values of ARRAY(50) and/or ARRAY(50,5) to the screen (Substitute LPRINT for PRINT or use ROUTE 128 to print to the printer). Use AUTO or make your own line numbers. It does not matter which numbers are used.

“One Dimension array PRINT routine”

```
   DIM ARRAY(50)
   FOR X=0 TO 50
     PRINT ARRAY(X)
   NEXT
```

“Two Dimension array PRINT routine”

```
   DIM ARRAY(50,5)
   FOR X=0 TO 50
     FOR X2=0 TO 5
       PRINT ARRAY(X,X2),
     NEXT X2
       PRINT
   NEXT X
```

MAKING AN ENTIRE ARRAY ONE VALUE

The following examples show how to make an entire array (ARRAY(50) or ARRAY(50,5)) equal to a certain value. This would be convenient if you wanted to zero out an array or have all the elements start the same values.

“One Dimension array ASSIGNMENT routine”

```
   DIM ARRAY(50)
   FOR X=0 TO 50
     ARRAY(X)=VALUE
   NEXT
```

“Two Dimension array ASSIGNMENT routine”

```
   DIM ARRAY(50,5)
   FOR X=0 TO 50
     FOR X2=0 TO 5
       ARRAY(X,X2)=VALUE
     NEXT X2
   NEXT X
```

USING ARRAYS FOR SORTING

Arrays are also very convenient for organizing large lists of data alphabetically or numerically, in ascending or descending order.

The first program below creates random data to sort. This program is for example purposes only and should not be included in your programs. **These programs are included on your master disk.**

Follow the GOSUB with the label of the sort routine you wish to use (either “QUICK SORT” or “SHELL SORT”). Any line numbers may be used. These sort routines may be copied and saved to disk (using SAVE* or +) as a subroutine to be loaded with APPEND. See APPEND.

SORT.BAS   FILL ARRAY WITH RANDOM DATA FOR SORTING

```
DIM SA(500), ST(30,1):   REM ST (30,1) FOR QUICK SORT ONLY.
NI=500:                  REM Change DIM 500 and NI if sort larger
FOR X=0TO NI
  SA(X)=RND(1000):       REM  Stores random numbers for sorting
NEXT
PRINT”Start Time:”;TIME$
GOSUB “QUICK SORT”:      REM Or SHELL SORT
PRINT”Finish Time:”;TIME$
FOR =NI-10 TO NI
  PRINT SA (X):          REM  Print last to make sure SORT worked.
NEXT
END
```

SHELL.APP   SHELL-METZNER SORT

```
“SHELL SORT”     Y=NI
“Z1”  Y=Y/2
IF Y=0 THEN RETURN:      REM Sort complete
Z99=NI-Y
FOR K9=1 TO Z99
  I=K9
  “X2” E2=I+Y
  REM:  In line below change <= to >= for descending order
  IF SA ( I  ) <= SA (E2) THEN “X3” ELSE SWAP SA ( I ), SA (E2)
  I=I-Y
  IF I>0 THEN “X2”
“X3” NEXT K9
GOTO “Z1”
END
```

Note: To sort string arrays instead of numeric arrays add a “$” to the appropriate variables.

Also see “Perpetual Sort” using INDEX$ in the previous chapter.

QUICK.APP QUICK SORT

```
“QUICK SORT”
REM Improve Quicksort submitted by Johan Brouwer, Luxembourg.
REM Thanks for the submission, Johan.
SP=0:ST(0,0)=0:ST(0,1)=0
ST(0,1)=NI
DO
  L=ST(SP,0): R=ST(SP,1):SP=SP-1
  DO
    LI=L: R1=R: SA=SA((L+R)/2)
    DO
      WHILE SA(LI) < SA
        LI=LI+1
      WEND
      WHILE SA(RI)>SSA
        RI=RI-1
      WEND
      LONG IF LI<= RI
        SWAP SA(LI), SA(RI)
        LI=LI+1:RI=RI-1
      END IF
    UNTIL LI>RI
    LONG IF (R-LI) >(RI-L)
      LONG IF L<RI
        SP=SP+1:ST(SP,0)=L: ST(SP,1)=RI
      END IF
      L=LI
    XELSE
      LONG IF LI<R
        SP=SP+1:ST(SP,0)=LI:ST(SP,1)=R
      END IF
      R=R1
    ENDIF
  UNTIL R<=L
UNTIL SP=-1
RETURN: REM QUICK SORT FINISHED HERE
END
```

Note: To use the QUICK SORT or SHELL SORT with STRING variables, use DEFSTR with the appropriate variables on the first line of the program or put a “$” after all variables that are strings.

Be sure to use DEFLEN or DIM to define the length of the string variables. If each element needs 50 characters, then set the length of SA$ to 50. The default is 256 bytes per element for string variables if you do not define the length.

HINTS ON TYPING IN THE PROGRAM: First of all, use line numbers of your own choosing. Indentation in this program is the way ZBasic shows the loops or repetitive parts of the program. You do not need to type in spaces (Make everything flush left). ZBasic will indent the listing automatically when you type LIST or LLIST.

Also see “Perpetual Sort” using INDEX$ in the previous chapter.

ARRAY VARIABLES

ARRAY ELEMENT STORAGE

The following chart illustrates how array elements for each type of variable are stored in memory.

Assumptions:

1. Memory starts at address zero (0)

2. Strings were dimmed: DIM 15 VAR$(1,2,2) (Each element uses 16 bytes*)

3. Other arrays dimmed: DIM VAR%(1,2,2) VAR!(1,2,2), VAR#(1,2,2)
(SINGLE and DOUBLE precision assumed as 6 and 14 digit accuracy.)

4. BASE OPTION of ZERO is assumed.

RELATIVE ADDRESSES

Array			**SINGLE**	**DOUBLE**
ELEMENTS	**STRING$**	**INTEGER%**	**Precision!**	**Precision#**
VAR(0,0,0)	00000	00000	00000	00000
VAR(0,0,1)	00016	00002	00004	00008
VAR(0,0,2)	00032	00004	00008	00016
VAR(0,1,0)	00048	00006	00012	00024
VAR(0,1,1)	00064	00008	00016	00032
VAR(0,1,2)	00080	00010	00020	00040
VAR(0,2,0)	00096	00012	00024	00048
VAR(0,2,1)	00112	00014	00028	00056
VAR(0,2,2)	00128	00016	00032	00064
VAR(1,0,0)	00144	00018	00036	00072
VAR(1,0,1)	00160	00020	00040	00080
VAR(1,0,2)	00176	00022	00044	00088
VAR(1,1,0)	00192	00024	00048	00096
VAR(1,1,1)	00208	00026	00052	00104
VAR(1,1,2)	00224	00028	00056	00112
VAR(1,2,0)	00240	00030	00060	00120
VAR(1,2,1)	00256	00032	00064	00128
VAR(1,2,2)	00272	00034	00070	00136

*Length byte adds one extra byte in front of each string element.

Note: Arrays are limited to 32,768 (0-32,767) elements.

LongInteger arrays are also supported. Each element takes four bytes. Macintosh is limited to 2,147,483,647 elements.

MSDOS version 4.0 has a limit of 32,768 (0-32,767) elements for integer arrays and a limit of 65,536 (0-65535) for string and floating point arrays.

GRAPHICS

GRAPHICS

GRAPHICS

Graphics are an extremely important way of communicating ideas. The old adage “A picture is worth a thousand words” is very true. ZBasic offers many powerful screen imaging commands and functions to take advantage of your computer’s graphics capabilities.

In addition to having powerful graphic commands,, ZBasic defaults to utilizing the same graphic coordinates regardless of the system you happen to be programming on. This is ideal for moving programs from one machine to another without having to make changes to the graphic commands or syntax. Quite a change from the old days.

Definitions of some commonly used graphic terms:

PIXEL The smallest graphic point possible for a given system. Some systems allow you to set the color of a pixel.

RESOLUTION Refers to the number of pixels (dots of light) on a screen. A computer with a resolution of 400 x 400 has 160,000 pixels (high resolution). A computer with 40 x 40 resolutions has only 1600 pixels (low resolution).

COORDINATE By giving a horizontal and vertical coordinate you can describe a specific screen location easily. With ZBasic the origin (0,0) is the upper left hand corner of the screen or window.

With a standard device independent coordinate system you can specify a location on the screen without worrying about pixel
positions.

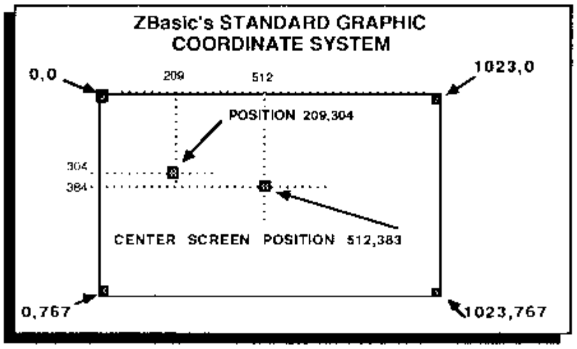
GRAPHICS

ZBASIC'S DEVICE INDEPENDENT GRAPHIC COORDINATE SYSTEM

ZBasic uses a unique DEVICE INDEPENDENT COORDINATE SYSTEM to describe the relative positions on a video screen, instead of a pixel system which describes specific graphic dots on the screen.

The standard coordinate system is 1024 points across (0-1023) by 768 points down (0-767). The width is broader to be in proportion to a normal video monitor.

This approach allows writing graphic programs the same way regardless of a computer's graphic capabilities.


ZBasic's STANDARD GRAPHIC COORDINATE SYSTEM
0,0
209
512
1023,0
POSITION 209,304
304
384
CENTER SCREEN POSITION 512,383
0,767
1023,767

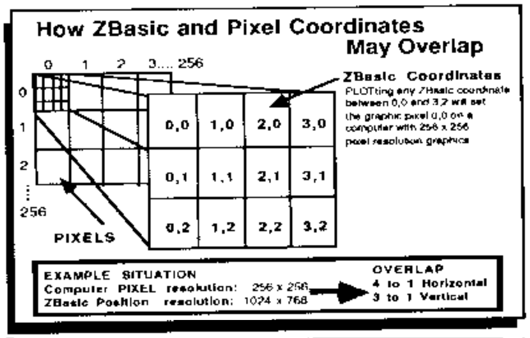
Device independent graphics means the coordinate syntax is the same regardless of the device or type of graphics being used!

The ZBasic approach to graphics makes commands function the same way ***EVEN ON DIFFERENT COMPUTERS!*** ZBasic handles all the transformations needed to match up the ZBasic coordinates to the actual resolution of the computer. This is an ideal way of handling graphics in a standardized way.

On the Macintosh the standard coordinates apply to the current window, not to the screen. Macintosh and MSDOS versions of ZBasic have the extra commands; COORDINATE and COORDINATE WINDOW which allow you to set relative coordinates of your own or pixel coordinates, respectively. See the Apple appendix for ways of configuring ZBasic to pixel coordinates. Some Z80 See appendix for specifics.

SCREEN PIXEL versus SCREEN POSITION

It is important to realize that ZBasic's standard coordinate system of 1024 x 768 has a direct relation to the screen, NOT to the actual pixel resolution of the computer being used. It is important not to confuse the pixel coordinate with the position coordinate:

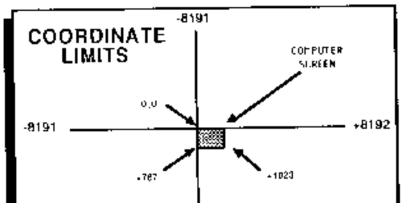

How ZBasic and Pixel Coordinates May Overlap
0
1
2
3.... 256
0
1
2
256
PIXELS
0,0
1,0
2,0
3,0
0,1
1,1
2,1
3,1
0,2
1,2
2,2
3,2
ZBasic Coordinates
PLOTting any ZBasic coordinate between 0,0 and 3,2 will set the graphic pixel 0,0 on a computer with 256 x 256 pixel resolution graphics
EXAMPLE SITUATION
Computer PIXEL resolution: 256 x 256
ZBasic Position resolution: 1024 x 768
OVERLAP
4 to 1 Horizontal
3 to 1 Vertical

You can see that plotting coordinates; 0,0 through 3,2, sets the same pixel on a screen with 256 x 256 resolution. If the pixel resolution of a computer is 64 x 64 then PLOTing 0,0 or 15,11 will plot the same pixel (16 to 1 horizontal and 12 to 1 vertical).

Fortunately this Information is rarely Important. ZBasic takes care of the tedious transformations between different graphic modes and resolutions. Skills learned on one machine may be used on any other machine that uses ZBasic!

OFF SCREEN COORDINATES

ZBasic allows coordinates to be given with graphic commands that are out of bounds of the actual screen coordinates. This allows drawing lines, circles or rectangles off the screen, with only that part of the graphics that are within bounds to be shown on the screen. ZBasic 'clips' the rest of the drawing.



The limits are from -8191 to +8192. Any coordinates given out of this range will cause an overflow and the actual result will be the overflowed amount without generating an error.

GRAPHICS

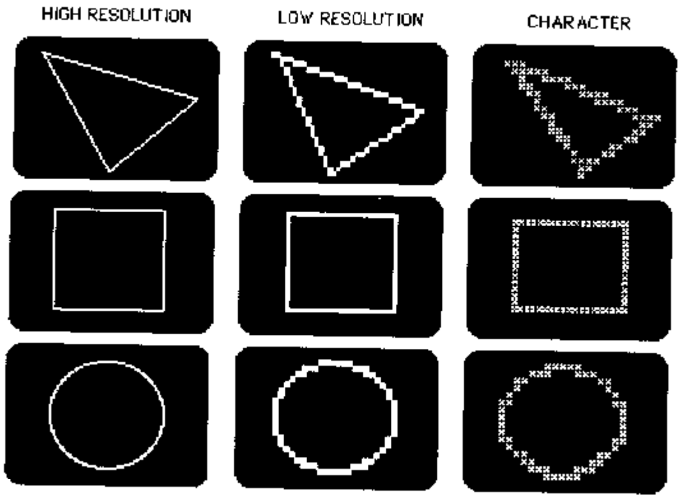
DIFFERENT TYPES OF GRAPHICS

Graphic appearance and quality will depend on the resolution of the computer or terminal you are using. Resolution is the number of graphics pixels on a screen. A computer with a resolution of 40 x 40 has 1600 different pixels. This is low resolution graphics because the graphic pints (pixels) are very large.

For computers without graphics, ZBasic will simulate the graphics as closely as possible using an asterisk. The resolution would be the number of characters across by characters down. See MODE.

GRAPHICS TYPE	RESOLUTION
HIGH RESOLUTION	about 200 x 150 or More
LOW RESOLUTION	about 150 x 100 or Less
CHARACTER	TEXT graphics simulation.

A COMPARISON OF LOW AND HIGH RESOLUTION IMAGES



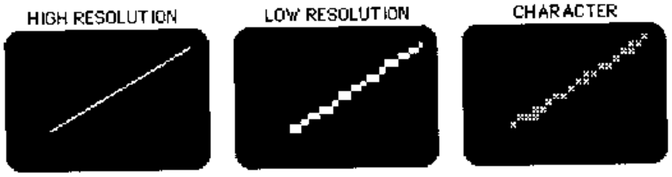
Notice the variation in quality. Programmers porting programs over to other machines should keep the resolution of the target computer in mind when creating programs.

MORE GRAPHIC EXAMPLES AT DIFFERENT RESOLUTIONS

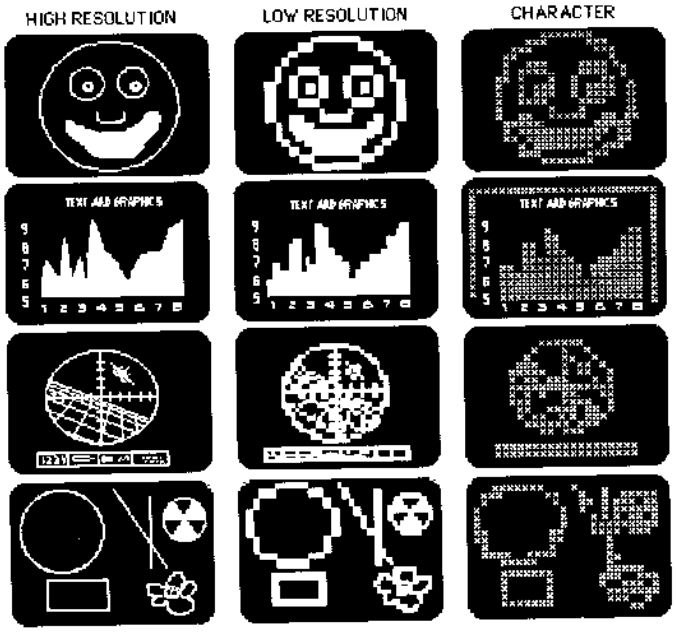
Quality deteriorates as graphic complexity increases and screen resolution decreases, although usually the lower the resolution the faster the execution speed. I this line example you can see the variation of quality.

The ZBasic statement to create all the lines in the first example was the same:

```
PLOT  60,660  TO 1000,  10:
```



Additional examples of more complex graphics forms in different resolutions:



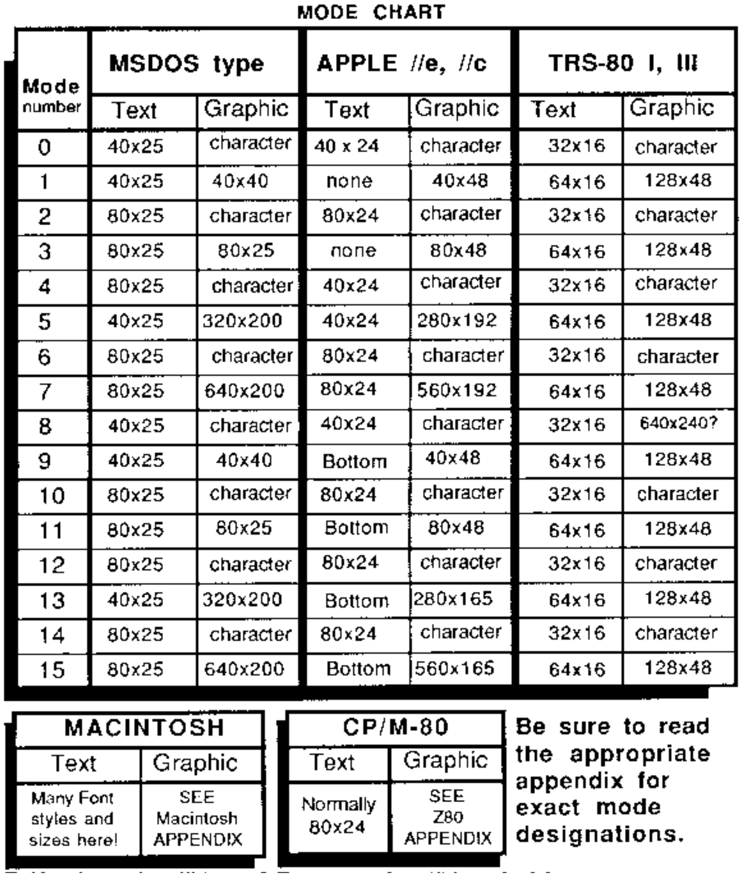
GRAPHICS

MODE

ZBasic offers different modes of text and graphics output depending on hardware and model. The ability to change modes allows you to simulate the output for different machines. Syntax:

MODE expression

The following chart gives the modes for some popular microcomputers, and illustrates how modes are grouped according to resolution.



MODE CHART

Mode number	MSDOS type		APPLE //e, //c		TRS-80 I, III	
	Text	Graphic	Text	Graphic	Text	Graphic
0	40x25	character	40 x 24	character	32x16	character
1	40x25	40x40	none	40x48	64x16	128x48
2	80x25	character	80x24	character	32x16	character
3	80x25	80x25	none	80x48	64x16	128x48
4	80x25	character	40x24	character	32x16	character
5	40x25	320x200	40x24	280x192	64x16	128x48
6	80x25	character	80x24	character	32x16	character
7	80x25	640x200	80x24	560x192	64x16	128x48
8	40x25	character	40x24	character	32x16	640x240?
9	40x25	40x40	Bottom	40x48	64x16	128x48
10	80x25	character	80x24	character	32x16	character
11	80x25	80x25	Bottom	80x48	64x16	128x48
12	80x25	character	80x24	character	32x16	character
13	40x25	320x200	Bottom	280x165	64x16	128x48
14	80x25	character	80x24	character	32x16	character
15	80x25	640x200	Bottom	560x165	64x16	128x48

MACINTOSH	
Text	Graphic
Many Font styles and sizes here!	SEE Macintosh APPENDIX

CP/M-80	
Text	Graphic
Normally 80x24	SEE Z80 APPENDIX

Be sure to read the appropriate appendix for exact mode designations.

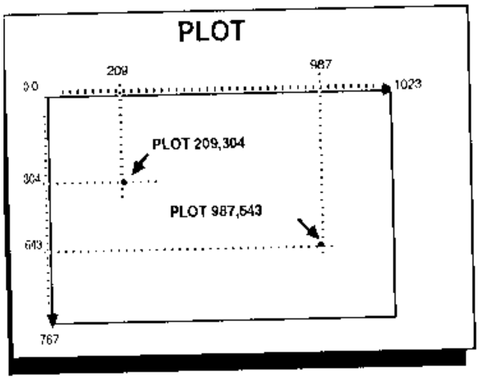
Note: Check your computer appendix for variations.

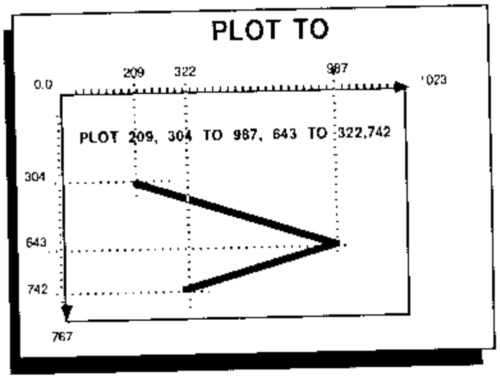
PLOTTING POINTS AND LINES

To set a specific screen position(s) to the current color or to draw lines from one screen position To another, TO another..., or to draw from the last screen position used (in another ZBasic statement) TO another...

PLOT [TO] horizontal , vertical [**TO** [horizontal , vertical [**TO**…]]]]

PLOT draws with the last color defined by COLOR. COLOR=0 is the background color of most computers, while COLOR=-1 is the foreground color. If you have a system with a black background, COLOR -1 is white and COLOR 0 is black. See COLOR in this chapter.





As with all other graphic commands, PLOT uses the standard ZBasic coordinates of 1024 x 768 regardless of the computer being used. When TO is used, ZBasic will plot a line from the first position TO the next position, TO the next position...

EXAMPLES OF PLOTTING	**RESULT**
PLOT 4,5	Turns on the pixel at the graphic position 4 positions over and 5 positions down.
PLOT 0,0 TO 1023,767	Plots a line from upper left corner of the screen down to the lower right corner of the screen.
PLOT TO 12,40	Draws a line from the last position used with the PLOT command TO the point on the screen 12 positions over by 40 positions down.
PLOT 0,0 TO 400,0 TO 0,300 TO 0,0	Plots a triangle in the upper left corner of the screen.

Note: All the examples above will plot in the current COLOR.

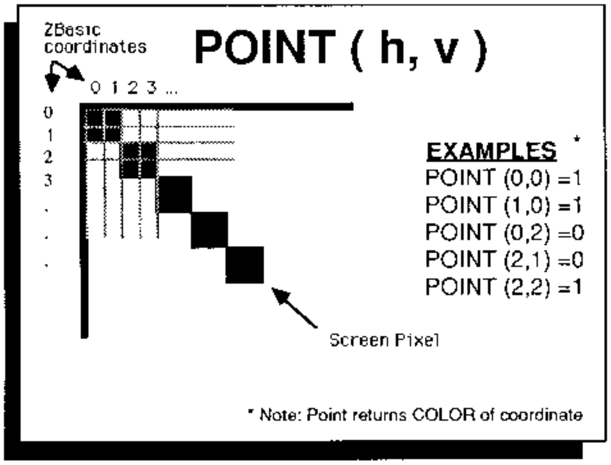
POINT

POINT (horizontal coordinate, vertical coordinate)

Returns the COLOR of the pixel at the ZBasic coordinate. Point is available on many computers to inquire about the COLOR of a specific screen graphic position (some computers do not have the capability to “see” pixels).

As with other commands, ZBasic Device Independent Graphic coordinates may overlap pixels. The following illustration shows the pixels and color types associated with them.

In this example: `0=BACKGROUND (WHITE)  1=FOREGROUND (BLACK)`



* Note: Point returns COLOR of coordinate

As with all other ZBasic graphic commands the standard device independent coordinate system of 1024 x 768 is used.

Note: The ZBasic device independent coordinate system specifies positions on the screen, not pixels. See below for ways of setting your system to actual pixel coordinates, if needed.

Macintosh and **MSDOS** systems can be set to use pixel coordinates with COORDINATE WINDOW. See **Apple** appendix for ways of configuring to pixel coordinates. **Z80** see your hardware technical manual and the Z80 appendix for specifics of your machine.

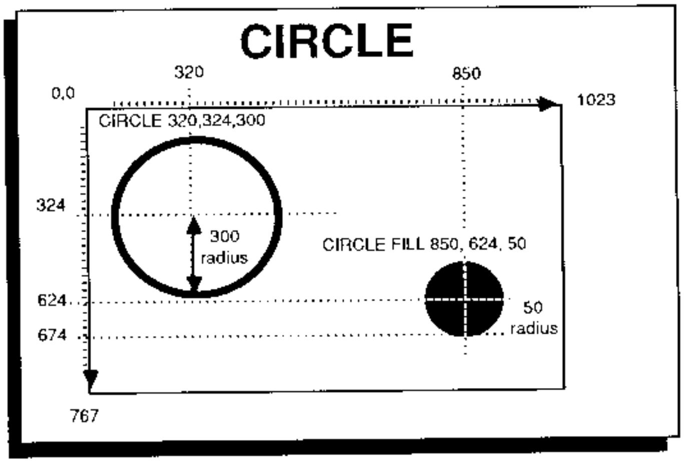
CIRCLE

CIRCLE [FILL] horizontal, vertical, radius

CIRCLE draws a circle in the currently defined COLOR and RATIO. COLOR=0 is the background color of most computers, while COLOR=-1 is the foreground color. If you have a system with a black background, COLOR -1 is white and COLOR 0 is black.

See RATIO for ways of changing the shapes of circles. Also see CIRCLE TO and CIRCLE PLOT for creating PIES and ARCS.

If FILL is used, the circle will be a solid ball in the current color.



As with all ZBasic graphic commands, the Device Independent Graphic Coordinates of 1024 x 768 are the default.

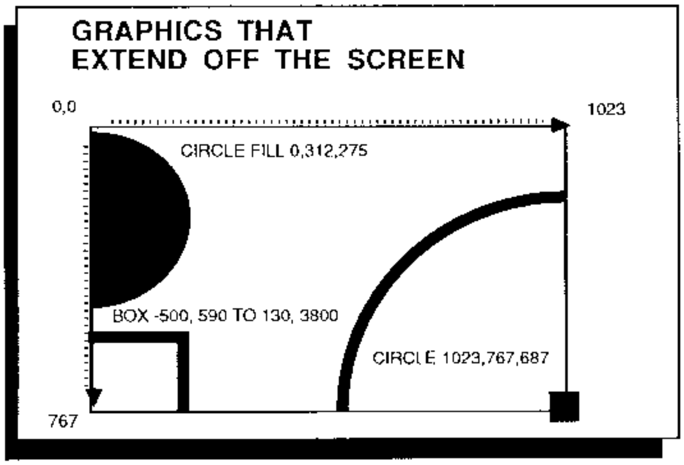
FILL is taken from PEN pattern; PEN,,,,n. Where n is one of the pen patterns used under the control panel. Quickdraw circles are also available using toolbox calls. See appendix.

GRAPHICS THAT EXTEND OFF THE SCREEN (CLIPPING)

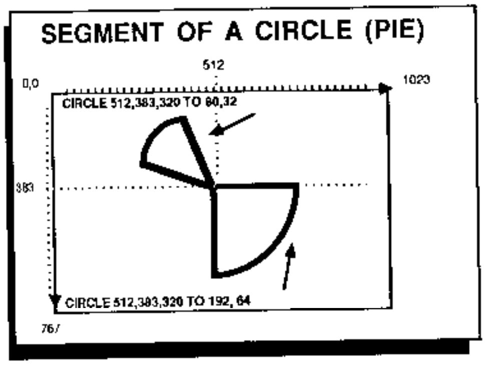
If coordinates are given that exceed the limits of the ZBasic screen coordinates, that part of the image exceeding the limits will be “CLIPPED”.

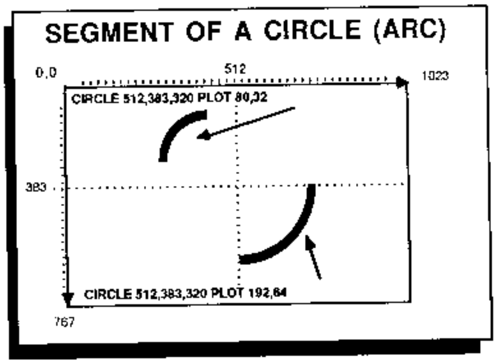
It is still permissible to use these numbers and in many cases it is important to have them available for special effects.

CIRCLE, or other graphic commands like PLOT, BOX, PRINT% etc., with coordinates that are off the screen but are within the limits of -8192 to +8192 are permissible and that part out of range will be “clipped”:



As with all ZBasic graphic commands, the Device Independent Coordinates of 1024 x 768 are used.


SEGMENT OF A CIRCLE (PIE)
512
0,0
1023
CIRCLE 512,383,320 TO 80,32
383
CIRCLE 512,383,320 TO 192, 64
767


SEGMENT OF A CIRCLE (ARC)
0,0
512
1023
CIRCLE 512,383,320 PLOT 80,32
383
CIRCLE 512,383,320 PLOT 192,64
767

SEGMENT OF A CIRCLE (PIE)

To draw an enclosed segment of the circumference of a circle (PIE), use this syntax:

CIRCLE *h,v,radius* **TO** *starting BRAD degree, number of BRADs* (counter clockwise)

CIRCLE draws with the last color defined by COLOR. COLOR=0 is the background color of most computers, while COLOR=-1 is the foreground color. If you have a system with a black background, COLOR -1 is white and COLOR 0 is black. See COLOR in this chapter.

SEGMENT OF A CIRCLE (ARC)

To draw a segment of the circumference of a circle (an ARC) use the syntax:

CIRCLE *h, v, radius* **PLOT** *starting BRAD degree, number of BRADs* (counter clockwise)

CIRCLE draws with the last color defined by COLOR. COLOR=0 is the background color of most computers, while COLOR=-1 is the foreground color. If you have a system with a black background, COLOR -1 is white and COLOR 0 is black. See COLOR in this chapter.

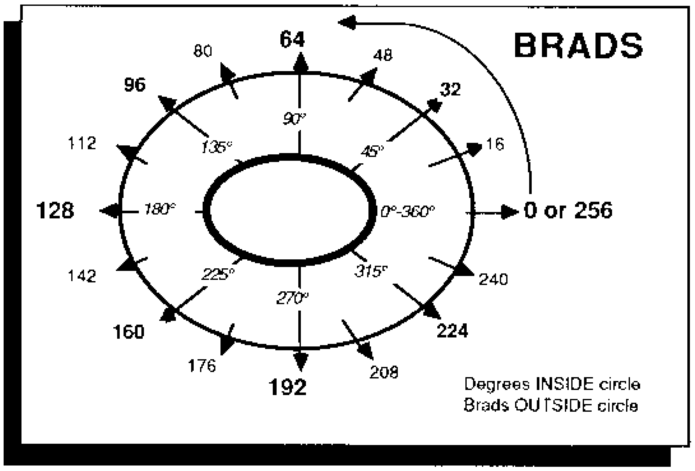
Note: 256 BRADS=360 DEGREES. See the BRAD chart on the next page. As with all ZBasic graphic commands, the standard coordinates of 1024 x 768 are used.

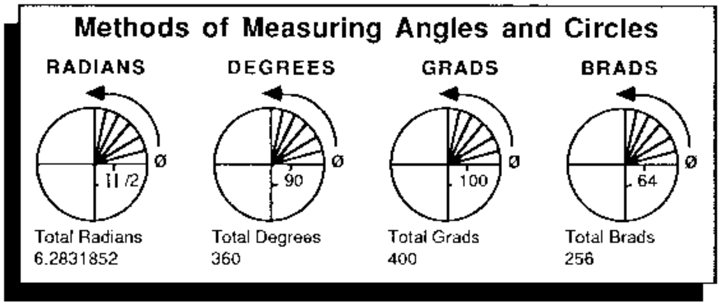
FILL may be used with the CIRCLE FILL x,y,r, TO s,n statement on this version. The FILL pattern is taken from PEN pattern; PEN,,,,n. Where n is one of the pen patterns used under the control panel. Quickdraw arcs are also available using toolbox calls.

BRADS

Brads are used with ZBasic CIRCLE commands to determine a position on the circumference of a circle. Instead of DEGREEs of zero to 359, BRADs range from zero to 255. (Starting at 3 O'clock going counter-clockwise.)

ZBasic™ BRAD CHART





CONVERSIONS FROM ONE TYPE TO ANOTHER

RADIANS=DEGREES*ATN(1)/45
RADIANS=9*GRADS/10
RADIANS=BRADS/40.7436666

DEGREES=RADIANS*45/ATN(1)
DEGREES=BRADS*1.40625
DEGREES=GRAD/63.66197723

GRADS=10 * DEGREES/9
GRADS=RADIANS*63.66197723
GRADS=BRADS*1.5625

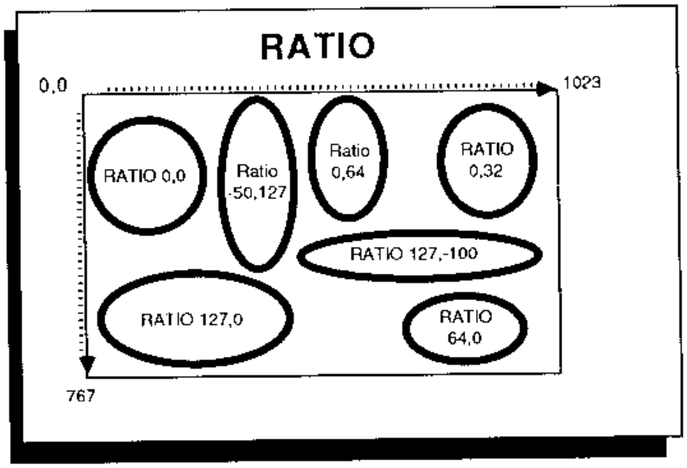
BRADS=DEGREES/1.40625
BRADS=GRADS/1.5625
BRADS=RADIANS*40.743666

Also see USR8 and USR9 for high-speed Integer SIN and COS.

RATIO

ZBasic allows you change the aspect ratio of any CIRCLE, ARC or PIE with the graphic statement RATIO:

RATIO *Width* (-128 thru + 127), *Height*(-128 thru +127)
(See CIRCLE)



Examples:

Ratio settings are executed immediately and all CIRCLE commands will be adjusted to the last ratio.

+127	=	2	times normal
+64	=	1.5	times normal
+32	=	1.25	times normal
0	=	0	**Normal proportion**
-32	=	.75	times normal
-64	=	.5	times normal
-96	=	.25	times normal
-128	=	0	(no width or height)

Quickdraw circles use box coordinates to set circle shape. See toolbox section of appendix.

GRAPHICS

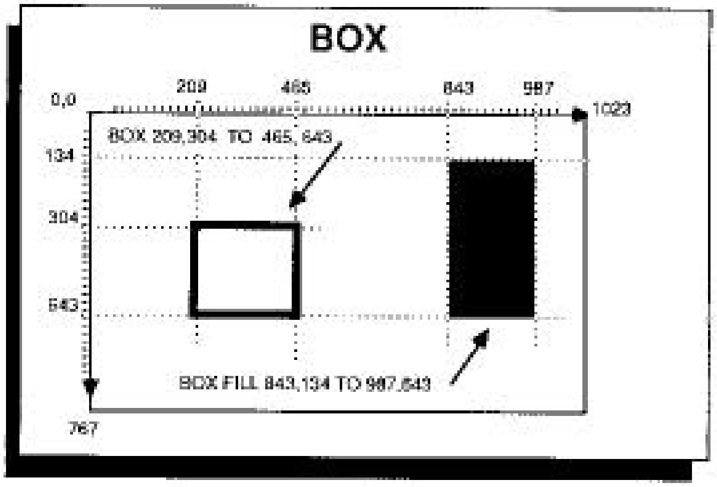
BOX

Box is used for drawing rectangles in the current color. The size of a rectangle is specified by giving the coordinates of opposing corners.

```
BOX  [FILL] h1, v1  TO  h2, v2
```

h1, v2 The first corner coordinate of the BOX.
h2, v2 The opposite corner coordinate of the BOX.

The BOX is plotted in the current color. If FILL is used the BOX will be filled with the current COLOR.



As with all ZBasic graphic commands, the device independent coordinates of 1024 x 768 are used. Notice the different quality of BOXes on various computers and different modes.

FILL is taken from PEN pattern; PEN,,,,n. Where n is one of the pen patterns used under the control panel. Quickdraw boxes are also available using toolbox calls. See appendix.

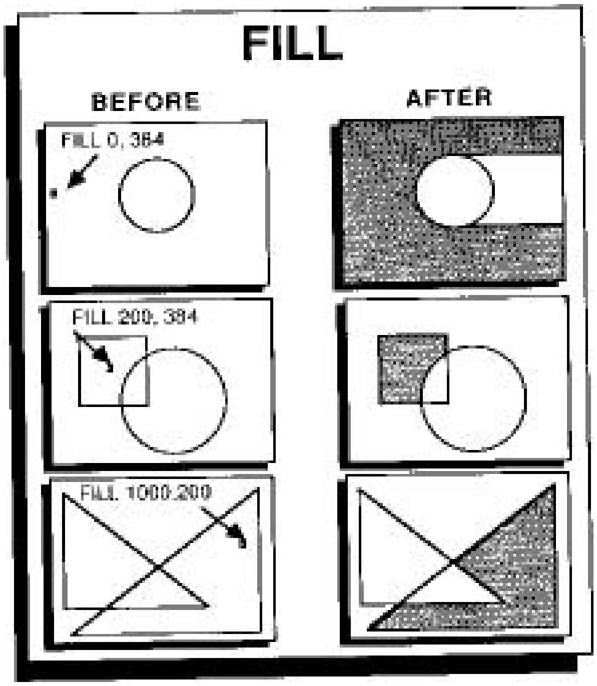
FILL

FILL Horizontal expression, Vertical expression

The fill command will fill a screen position from upper left most position it can reach without finding a color other than the background color, and down to the right and to the left until a non-background color is found.

This command will not function on computers lacking the capability to read screen pixel coordinates. See computer appendix.

Example:



As with all ZBasic graphic commands, the Device Independent Coordinates of 1024 x 768 are used.

Also see CIRCLE FILL and BOX FILL

FILL pattern is taken from PEN pattern; PEN,,,,n. Where n is one of the pen patterns used under the control panel. A much faster way to fill screen segments is using Quickdraw FILL with polygons, circles and rectangles. See appendix.

GRAPHICS

COLOR

COLOR is used to signify the color to be used with PLOT, CIRCLE, BOX and FILL. All systems support zero and -1 for background and foreground colors. (BLACK and WHITE respectively on most systems).

COLOR [=] expression

The following chart represents the color codes for IBM PC and compatible systems with color graphics. Colors codes vary significantly from system to system so check your computer appendix for variations.

IBM PC and Compatible COLOR codes

0= BLACK	8= GRAY
1= BLUE	9= LIGHT BLUE
2= GREEN	10= LIGHT GREEN
3= CYAN	11=LIGHT CYAN
4= RED	12= LIGHT RED
5= MAGENTA	13= LIGHT MAGENTA
6= BROWN	14= YELLOW
7= WHITE	15= BRIGHT WHITE

Color intensities will vary depending on the graphics hardware and monitor being used. Check your computer appendix for variations.

While most Macintoshes are black and white, COLOR is useful when printing to the ImageWriter II with a color ribbon. See appendix for details.

CLS, CLSLINE, CLSPAGE

CLS is used to clear the entire screen of graphics or text quickly. Optionally, the text screen may be filled with a specific ASCII character (in most modes). Check your computer appendix for variations.

CLS [ASCII code:0-255]

CLS LINE is used to clear a text line of text and graphics from the current cursor position to the end of that line.

CLS LINE

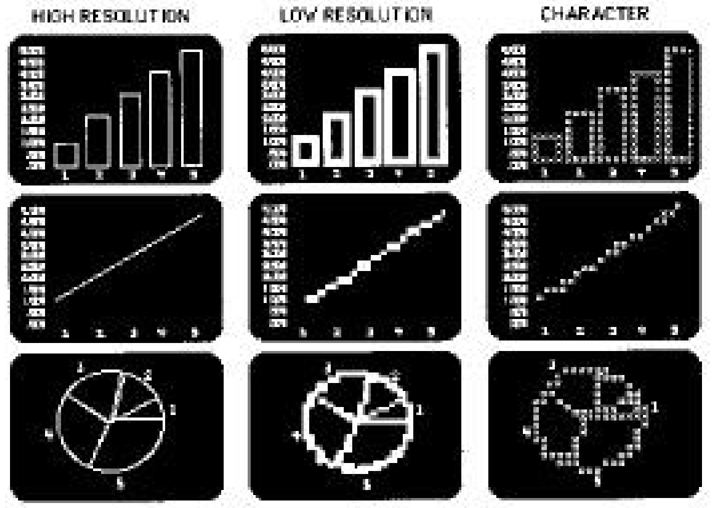
CLS PAGE is used to clear a text screen of text and graphics from the current cursor position to the end of the screen.

CLS PAGE

See Computer Appendix

BUSINESS GRAPHS, CHARTS ETC.

Business graphs and charts are easily accomplished with ZBasic graphics. An added benefit is that the graphs are also easily transported to different computers.



To further assist you in porting graph programs, ZBasic has two text commands that correspond to the graphic position on the screen instead of the text position:

PRINT%(h,v) Prints from the position specified by the ZBasic graphic coordinates.

INPUT%(h,v) Positions the input to be from the graphic position specified by h,v.

The syntax of these commands is the same as PRINT and INPUT. Also see PRINT@.

GRAPHICS

SPECIALIZED GRAPHICS

The Apple, MSDOS, Macintosh and some Z80 versions of ZBasic have some added powerful features for graphics. See the appendix for your version of ZBasic for specific information:

APPLE // GRAPHICS

Double Hi-Res with 16 colors is supported for the Apple //e, //c and //GS with 128k or more. Text and graphic may be integrated on the screen and customizable character sets are also supported. LONG FN's for DRAW, BLOAD and BSAVE are on the master disk.

IBM PC, MSDOS GRAPHICS

Version 4.0 supports most of the graphic modes of IBM PC's and compatibles including; Hercules Monochrome Graphics, Hercules PLUS, Enhanced Graphics Adaptor (EGA), Color Graphics Adaptor (CGA), Monochrome and all other graphics modes.

Also supported are GET and PUT graphic commands, PLOT USING, COORDINATE and COORDINATE WINDOW. See appendix for specifics.

MACINTOSH GRAPHICS

The master disk contains examples of printing and displaying MacPaint graphics and TIFF bit images. Also supported is GET and PUT graphics. PICTURE, TEXT, Apple's QuickDraw and toolbox routines, PEN and many more. See appendix for specifics.

TRS-80, CP/M-80 GRAPHICS

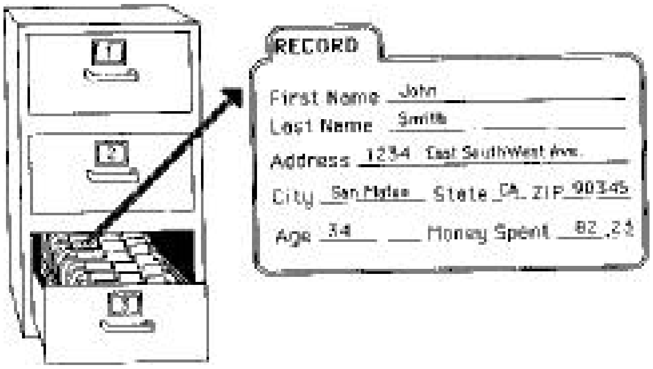
Most TRS-80 graphics are supported including Radio Shack's Hi-Res and Micro-Lab's Hi-Res boards on the Model 4 in MODE 8 and 15 (text and graphic integration is not supported with the Radio Shack Hi-Res board). Hi-Res is not supported on the model one or three.

Because of the diversity of machines for CP/M systems and because of a lack of common interface, graphics are not supported with CP/M systems (although we have special graphics versions for Kaypro 4 and 10 with graphics capabilities).

FILES

FILE HANDLING

ZBasic file commands are the same on all versions. This section explains file commands and statements. ZBasic file concepts are similar to a file cabinet:



RECORD

First Name John

Last Name Smith

Address 1234 East SouthWest Ave.

City San Mateo State CA ZIP 90345

Age 34 Money Spent 82.24

EVERYDAY TERMS	**ZBASIC TERMS**
FILE CABINET Holds files in drawers.	DISK OPERATING SYSTEM Holds files on diskettes, cartridges etc.
FILE Contains data for a mail list or inventory control system among other things.	FILENAME, FILENUMBER Contains data for a mail list or inventory control system among other things.
RECORD One logical part of a file: All the data for Mr. Smith in a mail list (name, address...)	RECORD One logical part of a file: All the data for Mr. Smith in a mail list file (name, address...)
PARTS OF A RECORD One part of a Record: The address or the City in a mail list record.	LOCATION One part of a RECORD: The address in a mail list record or even one character in the address.

FILES

GLOSSARY OF ZBASIC FILE TERMS

DOS: The Disk Operating System is a program residing in a computer's memory which takes care of the actual reading, writing and file control on a storage device such as floppy drives, hard drives, tape backup devices, etc. ZBasic works with the formats and syntax of each disk operating system using its syntax for such things as filenames, drive specs, etc.

FILENAME: Tells ZBasic which file to access. A string constant or variable is used.

FILESPEC: The part of a filename (or some other indicator) that specifies the device, directory or sub-directory a file is on. See your DOS manual for correct filespec syntax.

FILENUMBER: ZBasic may be configured to have from 0 to 99 files OPEN at the same time (if DOS and available memory permit). Filenumbers are used in a program with disk file commands to instruct ZBasic which file is being referred to. For example; if you open a file called "Fred" as number one, when doing file commands you need only refer to file number one, not "Fred". This saves a lot of typing.

RECORD: A record is one segment of a file. A mail list record might include Name, Address, City, State, ZIP, etc. If you want data from a specific record, it is called up using the RECORD command. The first record in a ZBasic file is RECORD 0. There may be up to 65,535 RECORDs in a file.* RECORD #filenumber, record, location.

SEQUENTIAL METHOD: This is a method of reading a file one element or record at a time, in order ---one after another i.e. 1,2,3,.. .

RANDOM METHOD: This is the method of reading file items randomly--- out of order. i.e. RECORD 20,90,1,22 ....

FILE POINTER: It is often important to know how to manipulate the file pointer. ZBasic allows you to position the file pointer by using RECORD, and tells you where the file pointer is currently positioned by using REC(filenumber) and LOC(filenumber).

COMPATIBILITY WITH MSBASIC™

Experienced BASIC programmers will like the power and simplicity of ZBasic file commands. For the first time, BASIC file handling commands have been made compatible and portable. All ZBasic disk commands function the same way regardless of the computer being used.

Sequential file commands are very similar. The main difference being that items written with PRINT# should be separated with quoted commas in ZBasic if being read back with INPUT#.

Random file commands have been made simpler, yet just as powerful. Those experienced with MSBASIC file commands should find the conversion painless:

ZBASIC COMMANDS	MSBASIC EQUIVALENTS
READ, WRITE, RECORD	FIELD, GET, PUT, MKI$, CVI, MKS$, CVS, MKD$,CVD, LSET, RSET
PRINT#, INPUT#, LINEINPUT#	PRINT#, INPUT#, LINEINPUT#

FILES

FILE COMMANDS COVERED IN THIS SECTION

This outline gives an overall perspective of file commands available in this section and groups commands in logical order. This section of the manual provides lots of examples and a tutorial for the file commands of ZBasic.

OPENING AND CLOSING FILES

OPEN
CLOSE

DELETING OR ERASING FILES

KILL

RENAMING A FILE

RENAME

POSITIONING THE FILE POINTER

RECORD

WRITING TO A FILE

WRITE#
PRINT#
PRINT#, USING
ROUTE

READING FROM A FILE

READ#
INPUT#
LINEINPUT#

GETTING IMPORTANT FILE INFORMATION

LOF
LOC
REC

🖥, 🖥, 🖥, 🖥

Be sure to read the appendix for your computer. Many versions have extra commands that take advantage of a particular system.

FILES

CREATING AND OPENING FILES

OPEN ["O, I or R"], filenumber, "filename" [,record length]

All ZBasic files must be opened before processing.

OPEN "O"
Opens a file for "O"utput only. If the file does not exist, it is created. If it does exist, all data and pointers are erased and it is opened as a new file.

OPEN "I"
Opens a file for "I"nput only. If the file does not exist, a "File Not Found" error is generated for that file number.

OPEN "R"
Opens a "R"andom access file for reading and/or writing. If the file does not exist, it is created. If the file exists, it is opened, as is, for reading or writing.

filenumber
ZBasic may be configured to have from 1 to 99 files open at one time in a program (depending on the DOS and available memory for that computer). Files are assigned numbers so ZBasic knows to which file it is being referred. The original copy of ZBasic is configured to allow up to two open files at a time. If you wish to have more files open, you may configure ZBasic for up to 99 open files. See "Configure".

record length
Record length is optional. If it is omitted, a record length of 256 characters is assumed. Maximum record length is 65,535 characters, or bytes (check appendix for variations).

EXAMPLES OF OPENING FILES

OPEN "O", 2, "NAMES", 99
Opens filenumber 2 as "NAMES", with a record length of 99 characters, for OUTPUT only. If "NAMES" doesn't exist, a file named "NAMES" is created. If a file called "NAMES" exists, all data and pointers in it are deleted and it is opened as a new file.
OPEN "I",1, A$
Opens filenumber 1 whose filename is the contents of A$, with assumed record length of 256 for INPUT only. If A$ doesn't exist, a "File Not Found" error is generated for filenumber one. See "Disk Error Trapping" for more information.
OPEN "R", 2, "BIGFILE" , 90
Opens filenumber 2 named "BIGFILE", with a record length of 90, for Reading and Writing.

🖥

OPEN"IR", "OR", "RR" for resource forks. OPEN "A" for append also supported. Volume number is used after record number i.e. OPEN"R",1,"Fred",99, vol%. A number of other enhancements are covered in the appendix.

CLOSING FILES

CLOSE[# filenumber [, filenumber,...]]

All files should be closed when processing is finished or before ending a program. *Failure to close files may result in lost data.*

CLOSE without a filenumber closes all open files (STOP and END will also CLOSE all files). It is very important to close all opened files before exiting a program. When a file is closed, the end-of-file-marker is updated and any data in the disk buffer is then written to the disk.

After you close a file, that filenumber may be used again with another OPEN.

DELETING FILES

KILL "filename"

Files may be deleted from the disk from within a program or from the editor with the "KILL" command. From the editor the filename must be in quotes on Macintosh and Z80 versions.

Filename is a simplestring and may be represented by a string constant or variable:

```
TRONB
INPUT"FILE TO KILL: ";FILE$
INPUT"ARE YOU SURE? ";A$
IF A$<>"YES" THEN END
KILL FILE$
END
```

RENAMING FILES

RENAME "oldfilename" TO [or comma] "newfilename"

Files may be renamed on the disk from within a program or directly using RENAME.

Filenames may be a string constant or variable. Example:

```
TRONB
INPUT"FILE TO RENAME";OLDFILE$
INPUT"NEW NAME: ";NEWFILE$
RENAME OLDFILE$ TO NEWFILE$
```

The TRS-80 Model 1,3 version does not support RENAME.

Macintosh: Both KILL and RENAME also use Volume number. See appendix for syntax. MSDOS: CHDIR and Pathnames may be used. APPLE ProDOS: Pathnames may be used.

FILES

WRITING TO A FILE USING PRINT#, WRITE# AND ROUTE#

PRINT#

PRINT# filenumber, (variables, constants or equations)[;","...]

PRINT# is used for writing data in TEXT format. It is saved to the disk quite like an image is saved to paper using LPRINT. PRINT# is useful for many things but it is not the fastest way or most efficient way to save data. See WRITE# below. Examples:

PRINT#1, A$;","; C$;","; Z% ;","; X#
Prints A$, C$, Z%, and X#, to filenumber one starting at the current file pointer. A carriage return* is written after the X#. This command stores data the same way it would be printed. Syntax is compatible with older versions of BASIC. The file pointer will point at the location in the file directly following the carriage return.*

PRINT#1, USING "##.##"; 12.1
Formats output to filenumber one starting at the current file pointer (stores 12.10). Functions like PRINT USING.

*Data MUST be separated by a delimiter of a quoted comma or a carriage return if reading data back using INPUT#. Some systems write a carriage return and a linefeed (two bytes).

WRITE#

WRITE[#] filenumber, variable [, variable...]

WRITE# is used for storing data in condensed format at the fastest speed. WRITE# may only be used with variables and data is read back with the READ# statement. Example:

WRITE#1, A$;10, Z%, K$;2
Writes 10 characters from A$, the value of Z%, and 2 characters from K$ to filenumber one, starting at the current file pointer. In the example; A$;10 stores A$ plus enough spaces, if any, to make up ten characters (or truncates to ten characters if longer).

ROUTE#

ROUTE [#] device

ROUTE is used to route output to a specific device. Device numbers are:

0	video monitor (default)	**1-99**	DISK filenumber (1-99)
128	PRINTER (same as LPRINT)	**-1 or -2**	SERIAL port 1 or 2*

Example of routing screen data to a disk file or serial port:

1. Open a file for output (use OPEN "C" and -1 or -2 for serial ports)
2. ROUTE to filenumber or serial port number that was opened.
   all screen PRINT statements will be routed to the device specified.
3. ROUTE 0 (so output goes back to the video)
4. Close the file or port using: CLOSE# n.

* Be sure to see your computer appendix for specifics.

READING FROM A FILE USING INPUT#, LINEINPUT# AND READ#

INPUT#

INPUT# filenumber, variable[, variable...]

INPUT# is used to read text data from files normally created with PRINT#. The data must be read back in the same format as it was sent with PRINT#. When using PRINT# be sure to separate data items with quoted comma or carriage return delimiters, otherwise data may be read incorrectly or out of sequence. Example:

INPUT#1, A$, C$, Z%, X#
Inputs values from filenumber one from the current RECORD and LOCATION pointer, into A$, C$, Z%, and X#. In this example the data is input which was created using the PRINT# example on the previous page. The file pointer will be pointing to the next location after X#.

LINEINPUT#

LINEINPUT# filenumber, variable **(One variable only)**

LINEINPUT# is used primarily for reading text files without the code limitations of INPUT#. Commas, quotes and other many other ASCII characters are read without breaking up the line. It will accept all ASCII codes accept carriage returns or linefeeds. TEXT is read until a carriage return or linefeed is encountered or 255 characters, whichever comes first:

LINEINPUT#5, A$
Inputs a line into A$ from filenumber five from the current file pointer. Accepts all ASCII codes including commas and quotes, except linefeed (chr10) and carriage return (chr 13). Terminates input after a chr 13, chr 10, End-of-file, or 255 characters.

READ#

READ [#] filenumber, variable [, variable...]

READ# is the counterpart of WRITE#. It is used to read back data created with WRITE# in condensed high-speed format. This is the most efficient way of reading files. Example:

READ#1, A$;10, Z%, K$;2
Reads 10 characters into A$, an integer number into Z%, and 2 characters into K$ from filenumber one, from the current file pointer. The file pointer will be pointing to the location directly following the last character in K$ (includes trailing spaces if string was less than ten).

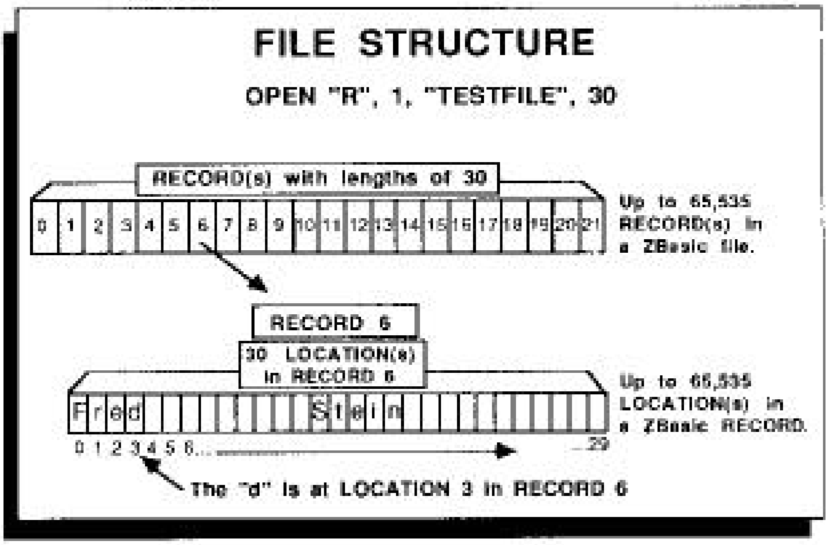
GETTING IMPORTANT INFORMATION ABOUT A SPECIFIC FILE

Syntax	Description
REC(filenumber)	Returns the current RECORD number location for filenumber.
LOC(filenumber)	Returns the current location within the current RECORD for filenumber (the byte offset).
LOF(filenumber)	Returns the last RECORD number of filenumber. If there are one or zero records in the file, LOF will return one. Due to the limitations of some disk operating systems this function is not always exact on some systems. Check the COMPUTER APPENDIX for specifics.

FILES

ZBASIC FILE STRUCTURE

All ZBasic files are a contiguous string of characters and/or numbers (bytes). The order and type of characters or numbers depends on the program that created the file.


FILE STRUCTURE
OPEN "R", 1, "TESTFILE", 30
RECORD(s) with lengths of 30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Up to 65,535 RECORD(s) in a ZBasic file.
RECORD 6
30 LOCATION(s) in RECORD 6
F r e d S t e i n
0 1 2 3 4 5 6... ...29
Up to 65,535 LOCATION(s) in a ZBasic RECORD.
The "d" is at LOCATION 3 in RECORD 6

In the illustration, the name "Fred Stein" was stored in RECORD six of "TESTFILE". To point to the "d" in FILENUMBER 1, RECORD 6, LOCATION 3 use the syntax:

```
RECORD#1,  6,  3
```

The location within a record is optional, zero is assumed if no location is given. If RECORD 1, 6 had been used (without the 3), the pointer would have been positioned at the "F" in "Fred" which is LOCATION zero.

If RECORD is not used, reading or writing starts from the current pointer position. If a file has just been OPEN(ed), the pointer is at the beginning of the file. (RECORD#n,0,0)

After each read or write, the file pointer is moved to the next available position in the file.

Macintosh: RECORD length and number of records is 2,147,483,647.

POSITIONING THE FILE POINTER

RECORD [#] filenumber, RECORD number [, LOCATION number]

To point to any LOCATION in any RECORD in any FILE, use:

RECORD 3,23,3 Sets the pointer of filenumber 3 to RECORD 23, LOCATION 3. If RECORD 23 contained "JOHN", then LOCATION 3 of this record would be "N", since zero is significant.

RECORD #3,23 Sets the pointer for file#3 to location zero in RECORD 23. If RECORD 23 contained JOHN, the character being pointed at would be "J".

RECORD IS OPTIONAL

If the RECORD statement is not used in a program, the pointer will have a starting position of RECORD 0, LOCATION 0 and is automatically incremented to the next position (for reading or writing) depending on the length of the data.

FILE SIZE LIMITATIONS*

The file size limitations for sequential files are either the physical limitations of the storage device or the limit of the Disk Operating system for that computer.

The limitation for Random access files is 65,536 records with each record containing up to 65,536 characters. Maximum file length is 4,294,967,296 characters (although multiple files may be linked to create larger files).

It is important to note that most Disk Operating Systems do not have this capability. Check your DOS manual for maximum file sizes and limitations.

Macintosh: RECORD length and number of records is 2,147,483,647.

CONFIGURING THE NUMBER OF FILES IN A ZBASIC PROGRAM

If the number of files is not configured, ZBasic assumes only 2 files will be used and sets aside only enough memory for two files.

To use more than 2 files, configure ZBasic for the number of files you need under "Configure".

ZBasic allows the user to configure up to 99 disk files for use in a program at one time (memory and disk operating system permitting). Each type of computer requires a different amount of buffer (memory) space for each file used so check your computer appendix for specifics (usually there are 256-1024 bytes allocated per file; 10 files would require between 2,560-10,240 bytes).

*See computer appendix for variations.

SEQUENTIAL METHOD

SEQUENTIAL METHOD

SEQUENTIAL METHOD

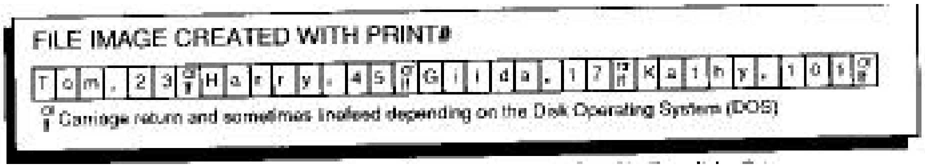
This section covers some of the methods that may used when reading or writing files sequentially. It covers the use of READ, WRITE, PRINT#, INPUT# and LINEINPUT#.

SEQUENTIAL METHOD USING PRINT# AND INPUT#

These two programs demonstrate how to create, write, and read a file with PRINT# and INPUT# using the Sequential Method:

```
PRINT#                              INPUT#
OPEN"O",1,"NAMES"                   OPEN"I",1,"NAMES"
DO: INPUT"Name: ";NAME$             DO: INPUT#1,  NAME$, AGE
  INPUT "Age:"; AGE                   PRINT NAME$","AGE
  PRINT#1,  NAME$","AGE             UNTIL NAME$="END"
UNTIL NAME$="END"                   CLOSE#1:END
CLOSE#1: END
```

Type "END" to finish inputting names in the PRINT# program. The INPUT# program will INPUT the names until "END" is read.



FILE IMAGE CREATED WITH PRINT#

```
|T|o|m|,|2|3|␍|H|a|r|r|y|,|4|5|␍|G|i|l|d|a|,|1|7|␍|K|a|t|h|y|,|1|0|1|␍|
```

␍ Carriage return and sometimes linefeed depending on the Disk Operating System (DOS)

Unless a semi-colon is used after the last data being printed to the disk, the end of each PRINT# statement is marked with a carriage return.

PRINT# USING

USING is used to format the PRINT# data. See "PRINT USING".

COMMAS IN PRINT# AND INPUT#

It is important to remember when using PRINT# with more than one data item, that quoted commas (",") must be used to set delimiters for data being written. If commas are not quoted, they will merely put spaces to the disk (as to the printer) and INPUT# will not be able to discern the breaking points for the data.

SEQUENTIAL METHOD

SEQUENTIAL METHOD USING READ# AND WRITE#

Other commands which may be used to read and write sequential data are READ# and WRITE#. The main difference between READ#--WRITE# and PRINT#--INPUT# is that the latter stores numeric data and string data, much the same way as it appears on a printer; READ# and WRITE# store string and numeric data in a more condensed and predictable format. In most cases this method is also much faster.

VARIABLES MUST BE USED WITH READ# AND WRITE#

READ# and WRITE# require that variables be used for data. Constants or expressions may not be used with these commands except the string length, which may be an expression, constant or variable.

HOW STRINGS ARE STORED USING WRITE#

When using WRITE# or READ# with strings, you must follow the string variable with the length of the string:

WRITE#1,**A$;10,B$;LB**   READ#1, **A$;10, B$;LB**

An expression may be used to specify the string length and must be included. When WRITE#ing strings that are shorter than the specified length, ZBasic will add spaces to the string to make it equal to that length. If the string is longer than the length specified, it will be "Chopped off" (If the length of A$ is 20 and you WRITE#1,A$;10, the last 10 characters of A$ will not be written to the file).

Normally, you will READ# strings back exactly the same way you WRITE# them. Notice that the spaces become a part of the string when they are READ# back. If you WRITE# A$;5, and A$="HI" when you READ# A$;5, back, A$ will equal "HI   " (three spaces at the end of it). The length of A$ will be 5.

To delete the spaces from the end of a string (A$ in this example), use this statement directly following a READ# statement:

```
WHILE ASC(RIGHT$(A$,1))=32: A$LEFT$(A$,LEN(A$)-1): WEND
```

You can use READ# and WRITE# using variable length strings as well. See the two format examples on the following pages.

READ# AND WRITE# IN CONDENSED NUMBER FORMAT

Numbers are stored in condensed format when using READ# and WRITE#. This is done to conserve disk space AND to make numeric space requirements more predictable. ZBasic automatically reads and writes condensed numbers in this format. Just be sure to read the data in exactly the same order and precision with which it was written. Space requirements by numeric variable type are as follows:

PRECISION	MAXIMUM DIGITS	SPACE REQUIRED
INTEGER	4.3 (+-32,767)	2 bytes
SINGLE PRECISION	6 (default)	4 bytes
DOUBLE PRECISION	14 (default)	8 bytes

Since single and double precision may be configured by the user, use this equation to calculate the disk space required if different than above:

(Digits of precision / 2) +1 = number of bytes per variable

LongInteger has 9.2 digits and requires 4 bytes for storage. To calculate the storage needs for Macintosh Double precision; Digits/2+2=space required per variable.

INTEGER NUMBER CONVERSIONS

For those programmers that want to control conversions these commands are available. They are not required with READ and WRITE since these commands do it automatically.

X=**CVI** (simplestring) Converts the first two bytes of simple-string to integer (X).
A$=**MKI$** (integer) Converts an integer to a 2 byte string

SINGLE AND DOUBLE PRECISION NUMBER CONVERSIONS

For those programmers that want to control conversions these commands are available. They are not required with READ and WRITE since these commands do it automatically.

X#=**CVB** (simplestring) Converts up to the first 8 bytes* of simplestring to an uncondensed double precision equivalent and stores the value in X#. (If string length is less than eight characters, only that many characters will be converted. At least two bytes are needed.)

A$=**MKB$** (X#) Converts a Double precision number to an 8 byte string.*

X!=**CVB** (simplestring) Converts the first 4 bytes* of simplestring into a single precision number and stores the value in X! If string length is less than eight characters, only that many characters will be converted. At least two bytes are needed.

A$=**MKB$** (X!) Converts a single precision number to a 4 byte string.*

*Note: The number of bytes of string space in the conversions depends on the precision set by the user. Use the equation above for calculating the space requirements. ZBasic assumes 8 bytes for double precision and 4 bytes for single precision if the user does not set precision.

To manipulate LongIntegers with MKI$/CVI use DEFSTR LONG. See Macintosh appendix.

SEQUENTIAL METHOD

SEQUENTIAL FILE METHOD USING READ# AND WRITE#

The following programs illustrate how to use READ# and WRITE# using the sequential file method.

USING READ# AND WRITE# WITH SET LENGTH STRINGS

The programs below create and read back a file with the sequential method using READ# and WRITE#. String length is set to 10 characters by the “10” following NAME$. ZBasic adds spaces to a string to make it 10 characters in length, then saves it to the disk.

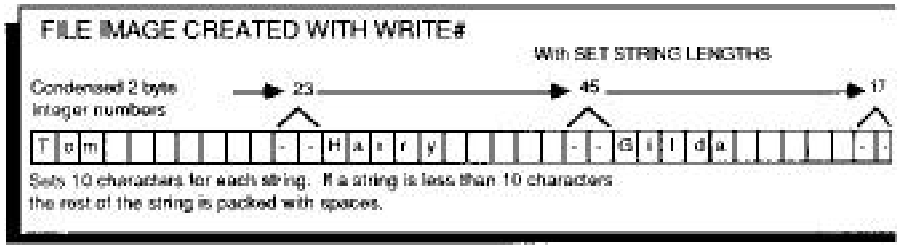
AGE is assumed to be an integer number since it was not defined and is stored in condensed integer format.

```
WRITE#                          READ#
OPEN”O”,1,”NAMES”               OPEN”I”,1,”NAMES”
DO: INPUT”Name: “; NAME$        DO: READ#1, NAME$;10,  AGE
  INPUT”Age:”; AGE                PRINT NAME$;”,”;AGE
  WRITE#1,NAME$;10,  AGE          A$=LEFT$(NAME$,3)
UNTIL NAME$=”END”               UNTIL NAME$=”END”
CLOSE#1: END                    CLOSE#1:END
```

Type “END” to finish inputting names for the WRITE# program. The READ# program will READ the names until “END” is encountered.

FIXED STRING LENGTH WRITE#

This illustration shows how strings saved with set lengths appear in a disk file:


FILE IMAGE CREATED WITH WRITE#
With SET STRING LENGTHS
Condensed 2 byte integer numbers
23
45
17
T o m
- -
H a r r y
- -
G i l d a
- -
Sets 10 characters for each string. If a string is less than 10 characters the rest of the string is packed with spaces.

The reason the ages 23, 45 and 17 are not shown in the file boxes is because the numbers are stored in condensed format (2 byte integer).

USING READ# AND WRITE# with VARIABLE LENGTH STRINGS

READ# and WRITE# offer some benefits over PRINT# and INPUT# in that they will read and write strings with ANY ASCII characters. This includes quotes, commas, carriage returns or any ASCII characters with a code in the range of 0-255. The following programs will save strings in condensed format, using the amount of storage required for each string variable.

WRITE#

```
OPEN"O",1,"NAMES"
DO: INPUT"Name: "; NAME$
  INPUT"Age:"; AGE
  LB$CHR$(LEN(NAME$))
  WRITE#1, LB$;1
  WRITE#1, NAME$;ASC(LB$),AGE
UNTIL NAME$="END"
LAST$="END":
WRITE#1,LAST$;3;CLOSE#1
END
```

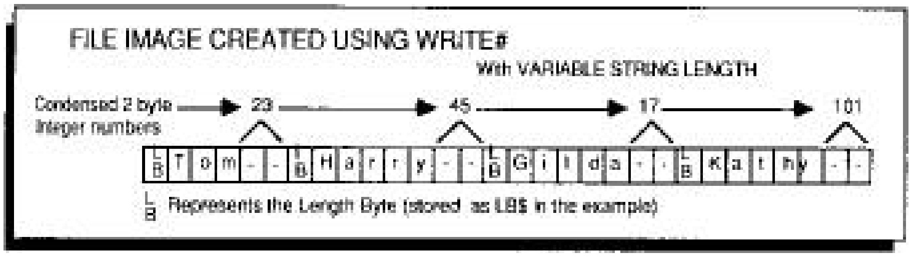
READ#

```
OPEN"I",1,"NAMES"
REM
DO: READ#1,LB$;1
  READ#1,  NAME$;ASC(LB$), AGE
  PRINT NAME$","AGE
UNTIL A$="END"
CLOSE#1
END
```

The WRITE# program stores a one byte string called LB$ (for Length Byte). The ASCII of LB$ (a number from 0 to 255) tells us the length of NAME$.

VARIABLE STRING LENGTH WRITE#

This illustration shows how the data is saved to the disk when string data is saved using the variable length method. LB for “Tom” would be 3, LB for “Harry” would be 5, etc...


FILE IMAGE CREATED USING WRITE#
With VARIABLE STRING LENGTH
Condensed 2 byte Integer numbers
23
45
17
101
LB T o m - - LB H a r r y - - LB G i l d a - - LB K a t hy - -
LB Represents the Length Byte (stored as LB$ in the example)

SEQUENTIAL METHOD

APPENDING DATA TO AN EXISTING FILE CREATED USING THE SEQUENTIAL METHOD

Sometimes it is faster (and easier) to append data to the end of an existing text file, instead of reading the file back in, and then out again.

This may be accomplished by using “R”, for random access file when opening the file, and keeping track of the last position in a file using REC(filenumber) and LOC(filenumber) and putting a character 26 at the end of the file.

To append sequentially to a text file created with other programs try using this example program. The key is setting the record length to the right amount. The MS-DOS version uses 128. Other versions will vary.

This example creates a function called: FN Open(f$, F%) and will OPEN the file named f$, with file number f%, for appending. The RECORD pointer will be positioned to the next available space in the file.

To close a file properly for future appending, use the function called FN Close (f$,f%).

```
LONG FN Open (f$,f%):  REM FN OPEN(f$, f%)
  OPEN “R”, f%, f$,128:REM Change 128 to correct # for your DOS
  Filelen%=LOF(f%): NextRec%=FileLen%: NextLoc%=0
  LONG IF FileLen%>0
    NextRec%=NextRec%-1
    RECORD #f%, NextRec%, NextLoc%
    READ #f%, NextRec$;128:  REM Change this 128 too!
    NextLoc%=INSTR(1,NextRec$,CHR$(26)): REM (zero on Apple)
    IF NextLoc%>0 THEN NextLoc%=NextLoc%-1 ELSE NextRec%=NextRec%+1
  END IF
  RECORD #%f, NextRec%, NextLoc%
END FN


LONG FN Close (f$, F%)
REM TCLOSE the file correctly with an appended chr 26.
PRINT#f%, CHR(26);
CLOSE#f%
END FN
```

Note: This method will work with ASCII text files ONLY!

See Open “A” in the appendix for opening files for Append.

RANDOM METHOD

CREATING FILES USING THE RANDOM ACCESS METHOD

Random access methods are very important in disk file handling. Any data in a file may be stored or retrieved without regard to the other data in the file. A character or field from the last record in a file may be read (or written) without having to read any other records.

A simple example of the Random access method is the following program that reads or writes single characters to any LOCATION in a file:

RANDOM ACCESS EXAMPLE USING A ONE BYTE RECORD LENGTH

```
OPEN  “R” , 1 ,”DATA”,1
REM   RECORD LENGTH = 1 character

“Get record number”
DO: INPUT “Record number: “;RN
  INPUT  “<R>ead,   <W>rite,  <E>nd:  “;A$
  IF A$=”R” GOSUB “Read” ELSE IF A$ = “W” GOSUB “Write”
UNTIL A$=”E”: CLOSE#1: END


“Write”
INPUT “Enter character: “ ‘ A$
RECORD #1,  RN
WRITE #1,A$;1  :RETURN

“Read”
RECORD #1,RN  :REM  Point at record# RN
READ #1,A$;1
PRINT” Character in RECORD# “; RN ;” was “ ;A$: RETURN
```

To change this program to one that would read or write people’s names, merely change the RECORD LENGTH to a larger number and increase the number after the A$ in the READ# and WRITE# statements.

The following pages will demonstrate a more practical use of the Random Access method by creating a mail list program in easy to understand, step by step procedures.

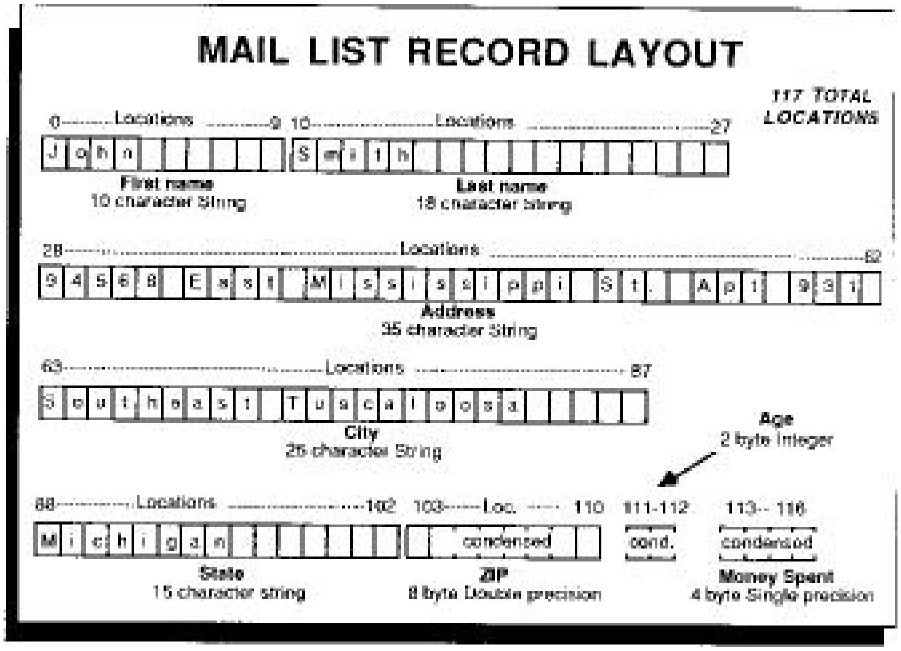
RANDOM METHOD

CREATING A MAIL LIST USING THE RANDOM ACCESS METHOD

This mail list uses: First and Last name, Address, City, State, Zip, Age and Money spent. The first thing to do is calculate the record length for the mail list file. This is done by calculating the space requirements for each field in a RECORD.

FIELD	VARIABLE TYPE	SPACE NEEDED
FIRST NAME	STRING$	10 characters
LAST NAME	STRING$	18 characters
ADDRESS	STRING$	35 characters
CITY	STRING$	25 characters
STATE	STRING$	15 characters
ZIP	DOUBLE PRECISION	8 bytes (holds up to 14 digits)
AGE	INTEGER	2 bytes (Holds up to 32,767)
MONEY SPENT	**SINGLE PRECISION**	**4 bytes (Holds up to 6 digits)**
Totals:	8 VARIABLES	117 bytes per RECORD

The following illustration illustrates how the mail list data is stored within each RECORD. LOCATION numbers are shown by position.



MAIL LIST PROGRAM

The following program will READ# and WRITE# mail list data as described on previous pages. The names are input from the user and a mail list record is created for each name.

You will be able to retrieve, print, and search for names in the mail list and, with some simple modifications (like using the sort routines in the ARRAY section of this manual) you will have a complete mail list program ready to use.

EXPLANATIONS OF THE MAIL LIST PROGRAM BY LINE NUMBER

10-21 Asks if you want to create a new file. If you say yes the old data is written over.

22 If old data is being used, the data in RECORD zero is READ to find out how many names are on the disk. NR holds the number of records on the disk.

25-77 Puts a menu on the screen and awaits user input.

80 “END” routine. Closes file and exits the program.

100-210 “ADD” names to mail list. Gets data from user, checks if OK. If not OK starts over. Note that the spaces in the input statements are for looks only. Space may be omitted.

220 If not OK then redo the input.

230-255 Gets the disk record (DR) from NR. Saves the variables to disk, then increments the number of records. (NR=NR+1) and saves it to disk record zero.

500-590 PRINT(s) all the names in the file to the printer. (Change LPRINT to PRINT for screen output).

700-780 “FIND” all occurrences of LAST NAME or PART of a LAST NAME. To find all the names that start with “G” just type in “G”. To find “SMITH” type in “SMITH” or “SMIT” or “SM”.

1000-1040 “READ A MAIL LIST ITEM”
READ(s) RECORD DR from the disk into the variables FIRST_NAME$, LAST_NAME$, ADDRESS$, ...

1100-1140 “WRITE A MAIL LIST ITEM”
WRITES the variables FIRST_NAME$, LAST_NAME$, ADDRESS$, ... out to the RECORD specified by DR.

HINTS: Spaces are not important when typing in the program, except between double quotes (if you have set “Spaces required between keywords” they will be required).

RANDOM METHOD

MAIL LIST PROGRAM EXAMPLE

```
0010  CLS
0015  OPEN”R”,1,”MAIL”,117
0016  INPUT”CREATE A NEW FILE:Y/N”;A$: IF A$><“Y” THEN 22
0021  NR=1: RECORD1,0: WRITE#1,NR:REM NR=Number of names in list
0022  RECORD 1,0: READ#1, NR
0025  DO: CLS
0030    PRINT”MAIL LIST PROGRAM”
0040    PRINT”1. Add names to list”, “Number of names: “;NR-1
0050    PRINT”2. Print list”
0052    PRINT”3. Find names”
0055    PRINT”4. End”
0060    INPUT@ (0,7)”Number: “;ANSWER: IF ANSWER<1 OR ANSWER>4THEN60
0075  ON ANSWER GOSUB “ADD”, “PRINT”,  “FIND”
0077  UNTIL ANSWER=4
0079  :
0080  “END”: CLOSE#1: END
0099  :
0100  “ADD”
101   CLS
102   PRINT”MAIL LIST INPUT”: PRINT
0130  INPUT”First Name: “;FIRST_NAME$
0140  INPUT”Last Name: “;LAST_NAME$
0150  INPUT”Address: “;ADDRESS$
0160  INPUT”City: “;CITY$
0170  INPUT”State: “;STATE$
0180  INPUT”ZIP: “ZIP#
0190  INPUT”AGE: “;AGE%
0200  INPUT”Money Spent:”;SPENT!
0210  PRINT
0220  INPUT”Is everything correct?  Y/N: “;A$:  IFA$<>”Y”THEN  “ADD”
0230  RECORD 1,0:READ#1,NR: DR=NR: NR=NR+1: REM NR is incremented
0240  GOSUB”WRITE A MAIL LIST ITEM”: REM when names added
0250  RECORD 1,0: WRITE#1, NR :    REM Stores records to record zero
0255  RETURN
0260  :
0261  :
0500  “PRINT”
0510  REM Change LPRINT to PRINT if screen output preferred
0515  RECORD 1,0:  READ#1,NR
0520  FOR X=1TO NR-1:   DR=X          :REM  DR=DISK RECORD
0530    GOSUB”READ A MAIL LIST ITEM”
0540    LPRINT FIRST_NAME$;”  “;LAST_NAME$
0550    LPRINT ADDRESS$
0560    LPRINT CITY$;”,”;STATE$;”   “;ZIP#
0570    LPRINT AGE%,  “SPENT:”; USING”$###,###.##”;SPENT!
0575    LPRINT:IF FLAG=99 RETURN
0580  NEXT
0585  DELAY 3000
0590  RETURN
```

Continued next page

```
0700  "FIND"
0704  CLS
0705  RECORD 1,0:READ#1, NR
0710  IF NR=1 THEN PRINT "No names to find!":DELAY 999:RETURN
0720  INPUT"NAME TO FIND: ";F$:F$=UCASE$(F$)
0730  FOR X=1 TO NR-1
0740    DR= X:  GOSUB"READ A MAIL LIST ITEM"
0750    T$=UCASE$(LAST_NAME$) :REM CASE must match
0755    IF INSTR(1,T$,F$) THEN FLAG=99: GOSUB 540: FLAG=0
0760  NEXT
0770  INPUT "LOOK FOR ANOTHER?  Y/N:";A$:IFA$="Y" THEN 700
0780  RETURN
0781  :
0782  :
1000  "READ A MAIL LIST ITEM"
1001  REM:This routine READS RECORD DR
1020  RECORD 1, DR
1030  READ#1, FIRST_NAME$;10, LAST_NAME$;18, ADDRESS$;35,
1035  READ#1, CITY$;25, STATE$;15, ZIP#,  AGE%,  SPENT!
1040  RETURN
1041  :
1042  :
1100  "WRITE A MAIL LIST ITEM"
1101  REM: This routine WRITES RECORD DR
1110  REM  CALL WITH DR=DISK RECORD NUMBER TO WRITE
1120  RECORD 1,DR
1130  WRITE#1, FIRST_NAME$;10, LAST_NAME$;18, ADDRESS$;35
1135  WRITE#1, CITY$;25, STATE$;15, ZIP#,  AGE%,  SPENT!
1140  RETURN:  END
```

MIXING FILE METHODS

MIXING FILE METHODS

MIXING SEQUENTIAL AND RANDOM FILE METHODS

Since ZBasic stores data as a series of bytes whether sequential methods or random methods are used, these methods may be intermixed.

The following program uses both methods. The program reads files from the mail list program created with the random access method earlier in this chapter.

The second and third lines read the number of records in the file. Then the list is read off the disk sequentially using the DO/UNTIL loop.

To read and print the mail list in sequential order:

```
OPEN”I”,1”MAIL”,117
RECORD 1.0:READ#1, NR:REM  Gets a number of records to read
RECORD 1,1: REM Set the pointer to the first record
REM    Change LPRINT to PRINT if screen output preferred
DO: NR=NR-1: REM  Counts down the number of names
  READ#1, FIRST_NAME$;10, LAST_NAME$;18, ADDRESS$;35,
  CITY$;25, STATE$;15, ZIP#,  AGE%  SPENT!
  LPRINT FIRST_NAME$;”  “;LAST_NAME$
  LPRINT ADDRESS$
  LPRINT CITY$;”,”;STATE$;”  “;ZIP#
  LPRINT AGE%, “SPENT: “; USING”$###,###.##”;SPENT!
 LPRINT
UNTIL NR=1: REM Until the last name is read
CLOSE#1
END
```

The READ#1 after the DO reads the data in. Whenever read or write functions are executed, ZBasic automatically positions the file pointer to the next position.

DISK ERRORS

DISK ERRORS

DISK ERROR MESSAGES

If a disk error occurs while a program is running, ZBasic will print a message something like this:

```
File Not Found Error in File #02
(C)ontinue  or  (S)top?
```

If you type “S”, ZBasic will stop execution of the program and return to the disk operating system (or to the editor if you are in interactive mode).

If you press “C”, ZBasic will ignore the disk error and continue with the program. This could destroy disk data!!

The following pages will describe how to “TRAP” disk errors and interpret disk errors which may occur.

END OF FILE CHECKING

Some versions do not have and “END OF FILE” command because some operating systems do not have this capability. Example of END OF FILE checking for some versions:

```
ON ERROR GOSUB 65535:  REM Set for User Error trapping
OPEN”I”,1,”DEMO”:IF ERROR PRINT ERRMSG$(ERROR):STOP
DO
  LINEINPUT#1,A$
UNTIL ERROR <>0
IF ERROR >< 257 THEN PRINT ERRMSG$(ERROR): STOP
REM 257=EOF Error in filenumber 1 (See error messages)
ERROR=0:REM  You MUST reset the ERROR flag.
ON ERROR RETURN:REM Give error checking back to ZBasic
CLOSE#1
```

Note: Many versions have an EOF function. See your appendix for details.

DISK ERRORS

TRAPPING DISK ERRORS

ZBasic provides three functions for disk error trapping:

ON ERROR GOSUB 65535 Gives complete error trapping control to the user. User must check ERROR (if ERROR<>0 then a disk error has occurred) and take corrective action if any disk errors occur. (Remember to set ERROR=0 after a disk error occurs). ZBasic will not jump to a subroutine when the error occurs. The 65535 is just a dummy number. See the ON ERROR GOSUB line:

ON ERROR GOSUB line GOSUB to the line number or label specified whenever and wherever, ZBasic encounters a disk error.

ON ERROR RETURN Gives error handling control back to ZBasic. Disk error messages will be displayed if a disk error occurs.

When you are doing the ERROR trapping it is essential that ERROR be set to zero after an error is encountered (as in line#45 and #1025 in the program example). Failure to set ERROR=0 will cause additional disk errors.

DISK ERROR TRAPPING EXAMPLE

The following program checks to see if a certain data file is there. If disk error 259 occurs (File Not Found error for file #1), a message is printed to insert the correct diskette:

```
10 ON ERROR GOSUB “CHECK DISK ERROR”
15 REM Line above Jumps to line 1000 if any disk error occurs
20 OPEN”I”,1,”TEST”
30 IF ERROR=0 THEN 50
40 INPUT”Insert Data diskette: press <ENTER>”;A$
45 ERROR=0:REM  You MUST reset ERROR to zero!
46 GOTO 20 :REM  Check diskette again...
50 ON ERROR RETURN: REM ZBASIC DOES DISK ERROR MESSAGES NOW...
  .
  .
  .
1000 “CHECK DISK ERROR”
1003 REM  ERROR 259 is “File Not Found Error in File #01”
1005  IF ERROR=259 RETURN
1010 PRINT ERRMSG$(ERROR)    :REM Prints error if not 259
1015 INPUT” (C)ont. or (S)top? “;A$
1020 A$=UCASE$(A$) :  IFA$<>”C” THEN STOP
1025 ERROR=0:REM    You MUST reset ERROR to zero!
1030 RETURN
```

Note: This method may not work on some Disk Operating Systems (like CP/M). Check your computer appendix for specifics.

DISK ERRORS

DISK ERROR CODES AND MESSAGES

If you wish to do the disk error trapping yourself (using ON ERROR GOSUB), ZBasic will return the ERROR CODE in the reserved variable word “ERROR”.

For instance, if a “File not Found Error in file# 2” occurs, then ERROR will equal 515. To decode the values of ‘ERROR’, follow this table:

DISK ERROR CODES & MESSAGES

ERROR	ERROR CODE
No Error in File #	0
End of File Error in File #	1 (257=file#1, 513=file#2, 769=file#3, etc.)
Disk Full Error in File #	2
File Not Found Error in File #	3
File Not Open Error in File #	4
Bad File Name Error in File #	5
Bad File Number Error in File #	6
Write Only Error in File #	7
Read Only Error in File #	8
Disk Error in File #	9-255

ERROR CODE=ERROR **AND 255**
FILE NUMBER=ERROR**>>8**

ERROR FUNCTION

ERROR returns a number between 0 and 32,767. IF ERROR does not equal zero than a disk error has occurred. The disk error code of the value returned in ERROR is deciphered by using one of the following equations or statements:

IF ERROR =515 calculate the disk error type by:
ERROR AND 255 =3   File Not Found Error in File #
ERROR>>8 =2   File Number is 2
ERRMSG$(ERROR)=   File Not Found Error in File #02

Also See ERROR and ERRMSG$ in the reference section.

Important Note: To avoid getting the same error again...ALWAYS set ERROR back to zero after and error occurs; ERROR=0.

Also see SYSERROR in the Macintosh appendix.

SCREEN AND PRINTER

SCREEN AND PRINTER

SCREEN AND PRINTER

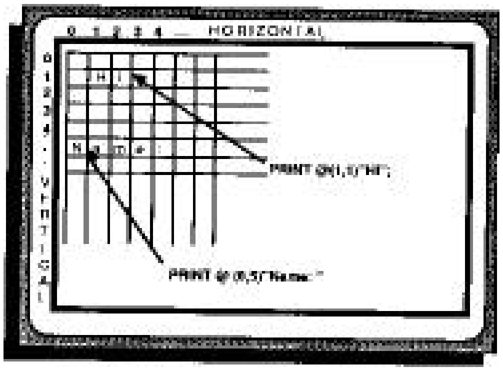
ZBasic has several functions and commands for screen and printer control. PRINT or LPRINT are the most frequently used. The following syntax symbols are used to control the carriage return and TAB for either PRINT or LPRINT:

PRINT SYNTAX	**RESULT**
Semi-Colon “;”	Suppress Carriage return and linefeed after printing. subsequent prints will start at the cursor position.
Comma “,”	TAB over to the next TAB stop. The default is 16: TAB stops are: 16, 32, 48, 64, ... 25 (also see DEF TAB below).
DEF TAB=n	Defines the space between the TAB stops for comma (,). Any number from 1-255. If 10 is used then positions 10, 20, 30, ...250, are designated as TAB stops.

PRINT EXAMPLES	**RESULT**
PRINT”HI”	Screen PRINT “HI” to the current cursor position and move to the beginning of the next line. <CR>
PRINT “HI”;	Screen PRINT “HI” and DON’T move to next line (the semi-colon suppresses the carriage return)
PRINT “HI”,	Screen PRINT “HI” and move over to next TAB position.
PRINT TAB(20)”HI”	Print “HI” at the 20th position over from the left or at the current position if past column 20.
PRINT ,”HI”	Print “HI” at the next TAB stop position. See “ DEF TAB”.
PRINT USING”##.##”;23.2	PRINTS 23.20 and moves to the next line. See “USING” in the reference section for further information.
POS(0)	Returns the horizontal cursor position on the screen where the next character will be printed.
POS(1)	Returns horizontal cursor position of the printer where the next character will be printed.

SCREEN AND PRINTER

PRINTING AT A SPECIFIC SCREEN LOCATION



PRINT @(H,V)"HI"
Start print H characters over horizontally and V lines down vertically from the upper left hand corner of the screen, then move to the beginning of the next line (Use a SEMI-COLON or COMMA to control the carriage return).

PRINT %(Ghoriz,m Gvert)
Position the print output to be at the graphics coordinates specified by Ghoriz, Gvert (or as close as possible for that computer. Great for easy porting of programs.

CLS [ASCII]
Fill Screen with spaces to the end of the LINE or to the end of the PAGE (screen).

STRING$(Qty, ascii or string)
Used to print STRINGS of characters. STRING$(10,"X") prints 10 X's to the current cursor position. STRING$ (25, 32) will print 25 spaces.

SPACE$(n) or SPC(n)
Prints n spaces from current cursor position.

COLOR [=] n
Sets the color of Graphics output and sometimes text. (0= background color, usually black. -1= foreground, usually white).*

MODE [=] n
Sets screen attributes. Some computers allow 80 character across or 40 characters across, etc.. Graphics may also be definable.*

ROUTE byte integer
Used to route output to the screen, printer or disk drive. *

* See Computer Appendix for specifics.

PRINT %

The PRINT % command functions exactly the same way as PRINT @ except the X-Y coordinate specifies a screen graphic position instead of a character position.

Since ZBasic utilizes device independent graphics, this is a handy way of making sure the text goes to the same place on the screen regardless of the computer being used.

Use MODE to set certain character styles for some computers.

Examples:

PRINT % (512, 383)	Print to middle of screen
PRINT % (0,0)	Upper left corner of screen
PRINT % (0,767)	Lower left corner of screen

🖥

Same as the toolbox MOVETO function. ZBasic coordinates unless COORDINATE WINDOW is used.

TYPICAL VIDEO CHARACTER LAYOUTS

Here are some of the typical character layouts for a few of the more popular computers:

COMPUTER	Columns (across)	Rows (down)
IBM PC and compatible	80 or 40	25
APPLE //E, //C	80 or 40	24
TRS-80 Model I, III	64 or 32	16
TRS-80 Model 4, 4p	80 or 40*	24
CP/M-80 computers	80	24
Macintosh	Almost anything...	See appendix

*Will also run TRS-80 models 1,3 version.

KEYBOARD INPUT

KEYBOARD INPUT

KEYBOARD INPUT

ZBasic utilizes the INPUT and LINEINPUT statements of getting keyboard data from a user. There are many options allowed so that input may be configured for most input types. Parameters may be used together or by themselves in any order. Syntax for INPUT and LINEINPUT:

[LINE]INPUT[;][[@or%] (horiz,vert);] [!] [& n,] ["string constant";] ar [, var[,...]

LINEINPUT — Optional use if INPUT. Allows inputting quotes, commas, and some control characters.

; — A semi-colon directly following "INPUT" disables the carriage return (cursor stays on same line after input).

& n, — "&" directly following "INPUT" or semi-colon, sets the limit of input characters to n. Length of strings used in INPUT must be one greater than n.

! — An exclamation point used with "&" terminates the INPUT when the character limit, defined by "&" , is reached, without pressing <ENTER>. If "!" is not used, <ENTER> ends input.

@(horiz, vert); — Positions the INPUT message to appear at character coordinates horiz characters over & vert lines down.

%(horiz, vert); — Positions the INPUT message to appear at the closest graphic coordinates horiz pixels over & vert pixels down.

"string constant"; — Prints a message in front of the input.

var [,var][,...] — The variable(s) to receive the input. Using more than one variable at a time is allowed except with LINEINPUT.

Important Note: When using strings with INPUT make sure that you define the length of the string at least one character more than will be input.

KEYBOARD INPUT

EXAMPLES OF REGULAR INPUT

EXAMPLE	RESULT
INPUT A$	Wait for input from the keyboard and store the input in A$. Quotes, commas and control characters cannot be input. <ENTER> to finish. A carriage return is generated when input is finished (cursor moves to beginning of next line).
INPUT"NAME: ";A$	Prints "NAME: " before input. A semi-colon must follow the last quote. A carriage return is generated after input (cursor moves to next line).
INPUT;A$	Same as INPUT A$ above, only the semi-colon directly after INPUT disables the carriage return (cursor stays on the same line).

EXAMPLES OF LIMITING THE NUMBER OF CHARACTERS WITH INPUT

EXAMPLE	RESULT
INPUT &10, A$	Same as INPUT A$ only a maximum of ten characters may be input. (&10) A carriage return is generated after input (cursor moves to the beginning of the next line). The limit of input is set for ALL variables, not each.
INPUT ;&10, I%	Same as INPUT &10, except the SEMI-COLON following INPUT stops the carriage return (cursor stays on line).
INPUT !&10, A$	Same as INPUT & 10 except INPUT is terminated as soon as 10 characters are typed (or <ENTER> is pressed).
INPUT ;!&10, "NAME: ";A$	Same as INPUT ;&10,A$ except no carriage return is generated (semi-colon). INPUT is terminated after 10 characters(&10 and Exclamation pint). and the message "NAME: " is printed first.
LINEINPUT;!&5,"NAME: ";A$	LINEINPUT A$ until 5 characters or <ENTER> is pressed. (no carriage return after <ENTER> or after the 5 characters are input. Accepts commas and quotes.)

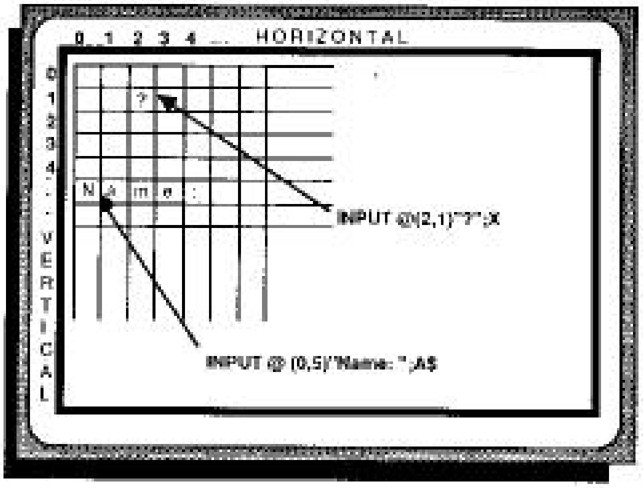
Note 1: Wherever INPUT is used, LINEINPUT may be substituted when commas, quotes or some other control characters need to be input (except with multiple variables).

Note 2: If more than one variable in INPUT, commas must be included from the user to separate input. If all the variables are not input, the value of those variables will be null.

In certain cases EDIT FIELD, MENU or BUTTON may be preferable. See appendix.

KEYBOARD INPUT

INPUTTING FROM A SPECIFIC SCREEN LOCATION



INPUT @(H,V); A$

Wait for input at TEXT screen POSITION defined by Horizontal and Vertical coordinates. No "?" is printed. A carriage return is generated.

INPUT %(gH,gV);A$

Input from a graphic coordinate. Syntax is the same as "@". Very useful for maintaining portability without having to worry about different screen widths or character spacing.

INPUT@(H,V);!10,"AMT: ";D#

Prints "AMT:" at screen position H characters over by V characters down. D# is input until 10 characters, or <ENTER>, are typed in, and the input is terminated without generating a carriage return (the cursor DOES NOT go to the beginning of the next line).

INPUT%(H,V);!10,"AMT: ";D#

Prints "AMT:" at Graphic position H positions over by V positions down. D# is input until 10 characters, or <ENTER>, are typed in, and the input is terminated without generating a carriage return (the cursor DOES NOT go to the beginning of the next line).

Note: Replace INPUT with LINEINPUT whenever there is a need to input quotes, commas and control characters (except with multiple variables).

KEYBOARD INPUT

INPUT %

The INPUT % command functions exactly the same way as INPUT@ except the X-Y coordinate specifies a screen graphic position instead of a character position.

Since ZBasic utilizes device independent graphics, this is a handy way of making sure the INPUT goes to the same place on the screen regardless of the computer being used.

Use MODE to set certain character styles for some computers.

Examples:

INPUT%(512, 383) middle of screen
INPUT%(0,0) upper left corner of screen
INPUT%(0,767) lower left corner of screen

Although all parameters above function properly, EDIT FIELD, MENU or BUTTON are preferable for getting user input. See appendix.

TYPICAL VIDEO CHARACTER LAYOUTS

Here are some of the typical character layouts for a few of the more popular computers:

COMPUTER	Columns (across)	Rows (down)
IBM PC and compatible	80 or 40	25
APPLE // series	80 or 40	24
TRS-80 Model I, III	64 or 32	16
TRS-80 Model 4, 4p	80 or 40	24
CP/M-80 computers	80	24
Macintosh	Almost anything...	See appendix

KEYBOARD INPUT

INKEY$

Unlike INPUT which must WAIT for characters, INKEY$ can receive characters from the keyboard "on the fly". When INKEY$ is encountered in a program, the keyboard buffer is checked to see if a key has been pressed. For computers with no buffer, the keyboard is checked when the command is encountered. If a key is pressed, INKEY$ returns the key. If no key has been pressed, INKEY$ returns a null string. Examples:

I$=INKEY$
When the program reaches the line with this command on it, ZBasic checks to see if a character is in the input buffer. If a key has been pressed it will be returned in I$. Otherwise I$ will contain nothing (I$ will equal "" or LEN(I$)=zero).

IF INKEY$="S" STOP
If the capital "S" key is pressed the program will stop. Sometimes more appropriate than using TRONB or TRONX for debugging purposes.

DO: UNTIL LEN(INKEY$) Wait for any key press, then continue
DO: UNTIL LEN(INKEY$)=0 Clears characters out of INKEY$ buffer

Note: TRONX, TRON or TRONB may cause INKEY$ to function improperly!

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Macintosh: If doing EVENT Trapping or any TRON type, the INKEY$ function may operate incorrectly. Use DIALOG(16) instead. See appendix for examples. **MSDOS**: See appendix for special ways of getting function keys (INKEY$ returns two characters).

INKEY$ EXAMPLE

The program below will wait awhile for a key to be pressed. If you make it wait to long, it will complain loudly. If you do press a key, it will tell you which key was pressed. If you press "S" or "s", the program will stop.

```
"Start": CLS
DO
  A$INKEY$:REM  Check if a key has been pressed
  X=X+1: IF X>3000 THEN GOSUB"YELL FOR INPUT!":REM Timer
UNTIL LEN(A$): REM If a key is pressed then LEN(A$)=1
PRINT "You pressed ";A$
X=0: REM  Reset timer
IF A$="S" OR A$="s" THEN STOP:  REM PRESS "S" to STOP!
GOTO "Start":REM  Go look for another key
:
"YELL FOR INPUT!": REM   This routine complains
PRINT"HURRY UP AND PRESS A KEY!  I'M TIRED OF WAITING"
X=0:REM  Reset Timer
RETURN
```

LOOPS

LOOPS

LOOPS

Loops are sections of a program that repeat over and over again until a condition is met.

Loops are used to make programs easier to read by avoiding IF THEN and GOTO, (although these commands may also be used to loop). ZBasic has a number of ways of looping or executing a routine until a condition is met.

* FOR, NEXT, STEP
*DO, UNTIL
WHILE, WEND

* Each of these loop types is executed at least once.

ENTERING OR EXITING LOOPS

ZBasic loops may be entered or exited without ill affects. Some compilers require you to use a loop EXIT statement. This is not required with ZBasic. Just use a GOTO or RETURN to exit as appropriate.

IMPORTANT LOOP REQUIREMENTS

ZBasic requires that each FOR has one, and only one, NEXT. Each WHILE must have one WEND and each DO must have one UNTIL. Otherwise a STRUCTURE error will result when you attempt to RUN the program.

AUTOMATIC INDENTING OF LOOPS

ZBasic automatically indents loops two characters in listings for readability (LIST).

LOOPS

FOR-TO-STEP
NEXT

FOR VAR counter= start expression TO end expression [STEP expression]
  Program flow...
NEXT [VAR counter]

STEP is an optional part of FOR/NEXT. If STEP is omitted, the step is one. An example of a FOR-NEXT-STEP loop:

```
FOR X=0 TO 20 STEP 2
  PRINT X;
NEXT X
program continues...
```

LINE 1: Begin the loop where X is incremented in STEPs of 2 (0,2,4,6...20)
LINE 2: Prints the value of X each time the loop is executed.
LINE 3: If X => 20 the loop falls through to line 4. X will equal 22 in line 4 of this example program.

FOR-NEXT loops will go through the loop at least once regardless of the values in the FOR instruction. See WHILE-WEND for immediate exiting.

To count backwards in a FOR/NEXT loop set STEP to a negative number.

Note 1: STEP zero will cause and endless loop.

*Note 2: With integer loops, be sure the maximum number is less than 32,767; otherwise an endless loop may occur for some systems. The reason for this is that the sign of the number increments to -32768 after 32767 which restarts the loop all over again! Endless loop example:

```
FOR X%= 1 TO 32767 <--Endless loop!
NEXT X%
```

Note 3: STEP number must stay within the integer range. STEP 32767 would create an endless loop.

Note 4: Unlike most other languages, FOR-NEXT loops may be entered or exited in the middle with no ill effects.

*The same problem arises with four byte integers when the maximum LongInteger number in the FOR loop exceeds 2,147,483,647.

DO UNTIL

DO
  Program flow...
UNTIL conditional expression is TRUE

```
DO
  X=X+2
  PRINT X;
UNTIL X>19
program continues...
```

LINE 1: Start of the DO loop
LINE 2: Make X=X+2
LINE 3: PRINT the value of X each time the loop is executed.
LINE 4: If X<20 then go back to the beginning of the loop. When X>19 program falls through to the next statement (line 4 in example)

A DO loop will execute at least once. In contrast to WHILE-WEND, which checks the condition at the beginning of the loop, DO-UNTIL checks the condition at the end of the loop. Use WHILE-WEND when you need to check the condition at the beginning.

Note: Unlike most other languages, the loop may be entered or exited in the middle with no ill effects. For instance, in line 2 above, you could used: IF X>10 then RETURN. This would not cause any problems in the program.

LOOPS

WHILE
WEND

WHILE conditional expression
  Program flow...
WEND end loop here when condition of WHILE is FALSE

```
          WHILE X<20
            X=X+2
            PRINT X;
          WEND
```

program continues...

LINE 1: Continue the loop while X is less than 20.
LINE 2: Make X=X+2
LINE 3: Print the value of X each time the loop is executed.
LINE 4: If X is less than or equal 20 then go back to the WHILE and do the loop again, otherwise continues at the first statement after WEND.

In contrast to DO-UNTIL and FOR-NEXT (which check the condition at the end of a loop), **WHILE-WEND checks the condition at the beginning of the loop and will exit immediately if the condition is not met.**

Note: Unlike most other languages, a WHILE-WEND loop may be entered or exited in the middle with no ill effects. For instance, in line 30 above, you could have used: IF X>10 then RETURN. This would not cause any problems in the program.

FUNCTIONS AND SUBROUTINES

FUNCTIONS AND SUBROUTINES

ZBasic contains some powerful tools for creating re-usable subroutines and appending or inserting them into other ZBasic programs that you create.

APPEND

APPEND is a command that will take an un-line numbered subroutine and insert it anywhere in an existing program. The syntax for the command is APPEND
line number or label, filespec.

To save a subroutine or program without line numbers, use the SAVE+ command. MERGE is available for merging subroutines or programs with line numbers into an existing program.

DEF FN

Zbasic incorporates the DEF FN and FN statements similar to many other BASIC languages. This is very handy for creating functions that may be used like commands in a program.

A function is given a name and may be called and passed variables. FN's save program space. Note that functions may utilize other functions within definitions and program code.

Examples of using DEF FN to create Derived Math functions.

```
DEF FN e# = EXP(1.)
DEF FN Pi# = ATN(1) << 2
DEF FN SEC# (X#) = 1. \ COS (X#)
DEF FN ArcSin# (X#) = ATN (X# \ SQR(1-X# * X#))
DEF FN ArcCos#(X#) = ATN(1.)*2-FN ArcSin# (X#)
```

Examples of program use:

```
PRINT FN Pi#
Angle# = SIN (FN ArcSin#(I#))
PRINT FN ArcCos#(G#)
```

Note: Be sure to define the function at the beginning of the program before attempting to use it otherwise an UN DEF error will result at compile time.

FUNCTIONS AND SUBROUTINES

LONG FN

Included is a sophisticated and powerful multiple line function called LONG FN.

LONG FN allows you to create multi-line functions as large as a subroutine and allows you to pass variables to the routine. This comes in very handy for creating reusable subroutines that you can insert or APPEND to other programs.

LONG FN is similar to DEF FN except that the function being defined may be many lines long. Use END FN to end the LONG FN subroutine. WARNING: Do not exit a LONG FN except at END FN otherwise system errors may result.

Example of LONG FN to remove trailing spaces from a string:

```
LONG FN  Remove trailing spaces from a string:
  WHILE ASC(RIGHT$(x$,1)=32
     x$= LEFT$(x$, LEN(x$)-1)
  WEND
END FN= x$
Name$="ANDY      "
PRINT X$, FN RemoveSpace$(Name$)
z$=FN  RemoveSpace$(fred$)
```

Example of a LONG FN for doing a simple matrix multiplication:

```
DIM A%(1000)
LONG FN MatrixMult%(number%,  last%)
  FOR temp%= 0 to last%
    A%(temp%)=A%(temp%)*number%
  NEXT
END FN
A% (0)=1: A%(1)=2:A%(2)=3
FN MatrixMult%(10,3)
PRINT A%(0), A%(1), A%(2)
```

SYNTAX OF DEF FN AND LONG FN NAMES

FN names have the same syntax as variable names. A function that returns a string value should end with a $. A function that returns a double precision value should end with a #.

AUTOMATIC INDENTATION

ZBasic automatically indents that code between a LONG FN and END FN so programs are easier to read.

SAVING FUNCTIONS FOR USE IN OTHER PROGRAMS

To save DEF FN'S or LONG FN's (or any subroutine) for future use, use SAVE+. This saves the subroutine without line numbers so it may be used in other programs by loading with the APPEND command (be sure to avoid line number references and GOTOs in subroutines to make them easily portable).

MORE EXAMPLES OF LONG FN

The following example will check to see if a random file specified by the filename file$ exists. If it does it will open it as a random file. If it does not exist, it will return a disk error.

Remember; with OPEN"R" if the file exists it is opened, if it doesn't exist it is created. You may not want it created in certain circumstances (like if the wrong diskette is in a drive).

```
LONG FN Openfile%(files$, filenum%, reclen%)
  ON ERROR 65535: REM Disk error trapping on
  "Open file"
  OPEN"I",filenum%,file$
  LONG IF ERROR
    LONG IF (ERROR AND 255) <>3
      PRINT@(0,0);"Could not find ";file$;" Check disk drive"
      INPUT"and press <ENTER> when ready";temp%
      ERROR=0: GOTO "Open file"
    END IF
  XELSE
    CLOSE# filenum%
  END IF
ON ERROR RETURN: REM Give error checking back to ZBasic
OPEN"R",filenum%, file$, reclen%
END FN
```

EASY GETKEY FUNCTION

```
LONG FN GetKey$(Key$)
  DO
    Key$=INKEY$
  UNTIL LEN(Key$)
END FN - Key$
```

MACHINE LANGUAGE SUPPORT

MACHINE LANGUAGE SUPPORT

MACHINE LANGUAGE

Occasionally it is important to be able to use machine language programs with your program, whether for speed or to utilize special features of the hardware of that machine. ZBasic incorporates a number of special commands to integrate machine language subroutines into your programs.

CAUTION: Unless you have a working knowledge of the machine language of the source computer and target computer, use extreme caution when porting programs with machine language commands or subroutines.

MACHLG

This statement allows you to put bytes or words directly into your program:

```
CALL LINE "Machlg": END
"Machlg": REM  EXAMPLE ONLY--> DO NOT USE!
MACHLG 10, 23 ,233, 12, 0, B%, A, 34, 12, &EF
MACHLG 23, 123, 222, 123, 2332, GameScore%, &AA
```

Hex, Binary, Octal or Decimal constants, Integer variables, or VARPTR may be used. Be sure to put a machine language RETURN at the end of the routine if using CALL. Be sure you understand the machine language of your computer before using this command.

LINE

This gives you the address of a specific line as it appears in the object code. This allows you to CALL machine language programs starting at specific line numbers or labels. Syntax is

LINE label
or LINE line number

Since the Macintosh is a 16 bit machine, MACHLG code is stored in WORDS not BYTES. The code above would be stored in every other byte. With LINE parentheses are required because it is also a toolbox call i.e. LINE (n).

MACHINE LANGUAGE SUPPORT

CALL

Allows you to CALL a machine language program. The syntax is:

CALL *address*

Be sure the routine being called has a RETURN as the last statement if you wish to return control to your program.

If you wish to CALL a machine language subroutine in your program that was made with MACHLG, use CALL LINE *line numbe*r or *label*.

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These versions have additional parameter passing capabilities. See appropriate appendix under CALL for specifics.

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The ProDOS version provides a special interface to the ProDOS Machine Language Interface (MLI). See appendix for specifics.

DEF USR 0 - 9

Allows you to set up to 10 different machine language user routines. The syntax for using this statement is:

DEFUSR *digit =address*

This command may be used to pass parameters or registers. See your computer appendix for the specifics about your computer. There are also default routines. See USR in the reference section.

INTEGER BASE CONVERSIONS

ZBasic makes integer BASE conversions simple. Some of the commands for converting between BASED:

BIN$, &X	**UNS$**
HEX$, &H or **&**	**OCT$, &O**

See "Numeric Conversions" for specifics.

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See DEFSTR LONG for configuring conversions above for LongInteger (and also CVI and MKI$).

MACHINE LANGUAGE SUPPORT

OTHER MACHINE LANGUAGE COMMANDS

Other tools for machine language programmers include powerful PEEK and POKE statements that can work with 8, 16 or 32 bit numbers and BOOLEAN MATH

PEEK, POKE

In addition to the “standard” BYTE PEEK and POKE provided by many versions of BASIC, WORD (16 bit) and LONG (*32 bit) PEEK and POKE are also provided:

PEEK	8 BIT	**POKE**	8 BIT
PEEKWORD	16 BIT	**POKEWORD**	16 BIT
PEEKLONG	*32 BIT	**POKELONG**	*32 BIT

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* Macintosh only at this time.

BINARY/BOOLEAN MATH FUNCTIONS

OR AND
XOR NOT
SHIFT LEFT SHIFT RIGHT

EXP and IMP may be emulated easily. See “Logical Operators” in the “Math” section of the manual.

VARIABLE POINTER

VARPTR (variable) will return the address of that variable.

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Macintosh: Remember to use LongIntegers to store the address since Macintosh memory exceeds 65,535 (the limit of regular integers). Also see DEFSTR LONG for defining integer functions to do LongInteger. MSDOS: Check appendix for way of determining SEG of variable.

STRUCTURED PROGRAMMING

STRUCTURED PROGRAMMING

STRUCTURE

Much has been said about the difficulty of reading BASIC programs and the so-called spaghetti code created (the program flow is said to resemble the convoluted intertwinings of string spaghetti).

While we believe structure is important, we don't believe that a language should dictate how a person should compose a program. This inhibits creativity and may even paint programmers into corners.

Nevertheless, we have provided powerful structure support in ZBasic.

THAT NASTY "GOTO" STATEMENT

The GOTO statement has been classified by many as a programmer's nightmare. If you want programs that are easy to read, do not use this command. If you must use GOTO, do not use line numbers, use labels to make the code easier to follow.

LINE NUMBERS VERSUS LABELS

The standard line editor (command mode) uses line number for three reasons:

1. Remain compatible with older versions of BASIC
2. For the Standard line editor commands
3. To give more easily understandable error messages

To make programs easier to read you should use alphanumeric labels for subroutines or any other area of a program that does a specific function.

It is much easier to follow the flow of a program if GOSUB, GOTO and other branching statements use labels instead of line numbers.

To LIST programs without line numbers use LIST+. Many versions of ZBasic now use full screen editors that don't require line numbers. See your appendix for specifics.

STRUCTURED PROGRAMMING

INDENTATION OF LOOPS, LONG FN and LONG IF

Some versions of structured languages require that you manually indent nested statements for readability.

ZBasic does all the indenting automatically!

Each nested portion of a program will be indented 2 spaces when the program is listed. Program statements like FOR-NEXT, WHILE-WEND, DO-UNTIL, LONG FN, LONG-IF etc. will be indented.

Example using LIST+:

```
LONG FN KillFile(file$)
  PRINT@(0,10);”Erase “;file$;” Y/N”;
  DO
    temp$=INKEY$
  UNTIL LEN(temp$)
  LONG IF temp$=”y” or temp$=”Y”
    KILL temp$
  END IF
END FN
FOR X=1 TO 100
   DO : G=G+1
     WHILE X<95
       PRINT “HELLO”
     LONG IF J< 4
        J=J+1
     END IF
     WEND
   UNTIL G >= 3.5
NEXT X
```

MULTIPLE LINE STATEMENTS

ZBasic allows putting more than one statement on a line with “:” (colon). While this is handy for many reasons, over-use of this capability can make a program line very difficult to understand.

```
UNSTRUCTURED   10*FORX=1TO100:DO:G=G+1:PRINT G:UNTILG=99:NEXT

STRUCTURED     FOR X = 1 TO 100
                 DO : G=G+1
                   PRINT G
                 FOR V=1 TO 20:NEXT
                 UNTIL G=99
               NEXT X
              *FOR V=1 TO 20:NEXT
```

*Note: An asterisk will appear at the beginning of a line containing a complete loop if that line is not already indented. In that case the line will be un-indented two spaces (as in the examples above).

STRUCTURED PROGRAMMING

SPACES BETWEEN WORDS

To make code more readable, you should insert spaces between words, variables and commands, just as you do when writing in English. While ZBasic does not care if spaces are used (unless you configure ZBasic to require spaces), it is a good practice to insert spaces at appropriate places to make reading the program easier.

Hard to Read	`IFX=93*24THENGOSUB”SUB56”ELSEEND`
Easier to Read	`IF X=93*24 THEN GOSUB “SUB56” ELSE END`

VARIABLE NAMES

To make code more readable, use logical words for variables.

Hard to Read	B=OP+I
Easier to Read	Balance = Old_Principle + Interest

ZBasic allows variable name lengths up to the length of a line, but only the first 15 characters in the name are significant. Do not use spaces or symbols to separate words in a name, use underlines; Building_Principle, Freds_House.

Keywords may not be used in variable names unless they are in lowercase and “Convert to Uppercase” is “NO” (this is the default). Also see next paragraph.

INCLUDING KEYWORDS IN VARIABLES

To allow keyword in variables configure ZBasic for; “Spaces Required after Keywords” (not available on all systems). See “Configure”.

HOW CASE AFFECTS VARIABLE NAMES

To make the variable “FRED” and “fred” the same variable configure ZBasic for “Convert to Uppercase”. See “Configure”.

GLOBAL VERSUS LOCAL VARIABLES

Programmers familiar with LOCAL variables in PASCAL and some other languages can structure their variable names to approximate this in ZBasic. (all ZBasic variables are global.)

GLOBAL variables should start with a capital letter.

LOCAL variables should start with lowercase. Many programmers also use (and re-use) variables like temp$ or local$ for local variables.

STRUCTURED PROGRAMMING

DEFINING FUNCTIONS

Use DEF FN or LONG FN to define functions and then call that function by name. This is easy reading for people trying to decipher your programs. It saves program space as well. FN names have the same definition as variable names. Passing values to functions in variables is also very easy.

LONG FN may be used when a function the size of a subroutine is needed. One FN may call previously defined functions.

LOADING PREVIOUSLY CREATED SUBROUTINES

To insert subroutines you have used in previous programs, use the APPEND command. This will append (or insert) a program saved with SAVE+ (a non-line numbered program or subroutine), into the current program starting at the line number you specify; APPEND linenumber or label filename

Be sure to avoid the use of line numbers or GOTO statements in your subroutine to make then more easily portable.

If using variables that are to be considered LOCAL, we recommend keeping those variables all lowercase characters to differentiate them for GLOBAL variables (all ZBasic variables are GLOBAL).

Sometimes LONG FN may be more appropriate for re-usable subroutines.

LISTINGS WITHOUT LINE NUMBERS

To make program listings easier to read, use LIST+ or LLIST+ to list a program without line numbers.

ZBasic automatically indents nested statements with LIST for even more readability.

🖥, 🖥

Macintosh: Listings can be sent to the Screen,m LaserWriter or ImageWriter without linenumbers and with keywords boldfaced by using LLIST+*.
MSDOS: Screen listings with highlighted keywords and no linenumbers are accomplished with LIST+* (no printer support for highlighted keywords).

LONG IF

For more control of the IF statement, ZBasic provides LONG IF for improved readability and power.

UNSTRUCTURED

```
10 IIFX=ZTHENY=10+H:G=G+Y:F=F+RELSEGOSUB122:T=T-1
```

STRUCTURED

```
LONG IF X=Z
  Y=10+H
  G=G+Y
  F=F+R
XELSE
  GOSUB"READ"
  T=T-1
END IF
```

UNSTRUCTURED

```
10 FORI=-3TO3:PRINT"I= ";I:IF I> THEN IF I>-3 AND I<3
PRINT I;">0",ELSEPRINT"Inner If False":GOTO 30
20 *PRINT I;"<=0",:X=-4:DO:X=X+1:PRINT"X=";X:UNTILX=I
30 NEXT I
```

STRUCTURED

```
FOR I = -3 TO 3: PRINT "I= ";I
  LONG IF I> 0
    LONG IF I > -3 AND I < 3
      PRINT I;"> 0",
    XELSE
      PRINT "Inner LONG IF false"
    END IF
  XELSE
    PRINT I;"<= 0",
    X = -4
    DO  X=X+1
      PRINT"X=";X
    UNTIL X=I
  END IF
NEXT I
```

Important Note: Any loops enclosed in LONG IF structures must be completely contained with the LONG IF, END IF construct.

The Macintosh and IBM versions also support SELECT CASE, a structured, multi-conditional LONG IF statement. See appendices for syntax.

DEBUGGING TOOLS

DEBUGGING TOOLS

DEBUGGING TOOLS

To get programs running bug-free in the shortest amount of time, ZBasic has incorporated some powerful error catching tools.

TRON Display program flow

Turns on the line trace statement. As the program is running, ZBasic will display the line number where the program is being executed on the screen.

Also see TRON 128 for sending the line numbers to the printer so the display is not affected.

TRONS Single Step

SINGLE STEP line trace debugging. Allows you to single step through that part of a program. To activate single step mode press CTRL Z. To single step press any key. To return to regular mode press CTRL Z again. To single step and display line numbers use TRONS:TRON. Note: CTRL S and CTRL Z will function during any TRON type.

TRONB Check for <BREAK> key

Sets a break point on that line and all the following lines of that program (until a TROFF is encountered). As each line is executed, the program will check if CTRL C or <BREAK> is being pressed.

If <BREAK> is pressed, the program will return to the edit mode (the operating system if RUN* was used). Without a break point the program will not respond to the <BREAK> key. No line numbers are displayed unless TRON was also used.

BREAK ON is often preferable as a check for <COMMAND PERIOD>. See appendix.

DEBUGGING TOOLS

TRONX Check for <BREAK> on that line only

Sets a break point only on that line. If CTRL C or <BREAK> is pressed as that line is executed, the program will return to the edit mode (if interactive) or to the operating system.

TROFF Disable all TRON modes

Turns off TRON, TRONB, TRONX and TRONS. Line number display and <BREAK> points will be disabled in the program flow following this statement.

ARRAY BOUNDS CHECKING

Set "Check Array Bounds" to "YES" when configuring ZBasic to make sure you do not exceed DIM limits. This is a RUN TIME error check and is very important for use during the debug phase.

Exceeding array limits could cause overwriting of other variables and faulty data.

After you have finished debugging your program, disable this function since it will slow execution speed and increase program size.

STRING LENGTH CHECKING (not all versions; check your appendix)

Set "String Length Checking" to "YES" when configuring ZBasic to make sure you do not exceed defined string length limits. This is a RUN TIME error check and is very important for use during the debug phase.

Exceeding string lengths could cause overwriting of other variables and/or faulty data.

After you have finished debugging your program, you may wish to disable this function since it will slow execution speed and increase program size.

COMPILE TIME ERROR CHECKING

ZBasic compile time error messages help you pinpoint the cause of the problem immediately by highlighting the error on the line and printing a descriptive message instead of an error number.

Unlike BASIC interpreters, ZBasic will not execute a program with syntax errors in it. If the program compiles without an error you can be sure it is at least free of syntax errors.

DISK ERROR CHECKING

ZBasic gives the programmer a choice of trapping disk errors themselves or letting ZBasic display the disk error. See "Disk Error Trapping" for more information.

PORTING PROGRAMS

PORTING PROGRAMS

Porting means taking a program from one computer and moving it to another computer of different type or model. As from an Apple to an IBM.

Because most ZBasic commands contained in the reference section of this manual (except USR, OUT, INP, PEEK, POKE, VARPTR, CALL and MACHLG) function the same way, it is very easy to move the source code from one machine to another.

The following pages will describe some of the problems and solutions of porting programs.

OBJECT CODE AND SOURCE CODE

There are two separate types of programs created with ZBasic and you should understand the differences.

SOURCE CODE This is the text part of a program you type into the computer and looks like the commands and functions you see in this manual. In order to turn SOURCE CODE into OBJECT CODE, ZBasic compiles it when you type RUN (or RUN* or RUN+).

OBJECT CODE The OBJECT CODE is what ZBasic creates from the SOURCE CODE after you type RUN. Object code is specific to a certain machine. i.e. an IBM PC uses an 8088 CPU and an Apple // uses a 6502 CPU. The ZBASIC OBJECT CODE for each of these machines is different and cannot be ported. Port the SOURCE CODE to the target machine and then recompile it into the OBJECT CODE of that computer.

FILE COMMANDS

ZBasic file commands work almost exactly the same way from one computer to the next. The areas to be aware of when porting code from one machine to another are covered in the following two paragraphs.

PORTING PROGRAMS

DISK CAPACITIES

Make sure the target machine has enough storage space to accommodate the program and program files being ported.

COMMON DRIVE CAPACITIES		
IBM PC, XT, jr.	5.25”	320K-360K
	3.50”	780K
IBM PC AT	5.25	360K
	3.50”	780K
	variable density	1200k
Apple // series	5.25”	143k
	3.50”	800k
Macintosh	single sided	400K
Macintosh Plus	double sided	800K
Other:		
SSSD	5.25”	80K
SSSD	8.00”	200-500K
SSDD	5.25”	160K
DSDD	5.25”	320K
DSDD	8.00”	600-2000K

SSSD: Single sided Single density
SSDD: Single sided Double density
DSDD: Double sided Double density

FILESPECS

ZBasic filenames/filespecs work within the limitations of the disk operating system. When porting programs make sure the filespecs are corrected. For instance; if porting a program from a TRS-80 Model 3 to an IBM PC, you must change all references to a file like; FRED:1 to A:Fred

Some computers cannot do RENAME or EOF. Others are incapable of certain DISK ERRORS. Be sure to study the DOS manual of the target machine for variations.

MEMORY

Memory is another area of importance when porting programs from one machine to another.

Porting from smaller machines to machines with larger memory should not be a problem, as long as other hardware is similar. Programs from TRS-80 MODEL I, III, 4, Apple //e and //c and CP/M 80 machines should port over to an IBM PC or Macintosh with little or no changes.

Porting a large program (128K or more) from a larger machine like an IBM PC or Macintosh to a smaller machine will require a number of memory saving measures covered in the following paragraphs:

CHAINING PROGRAMS TOGETHER

If a 128K program is being moved to a 64K system, you will have to split it up into two or more separate programs and CHAIN them together. Since ZBasic allows sharing variables while chaining, this should solve most problems.

CHECK STRING MEMORY ALLOCATION

ZBasic allows the user to change the size of strings. Since some programmers on larger machines may not be concerned with creating efficient code or keeping variable memory use down, check if string size has been set. Setting string size from the 256 byte default to 32 or 64 will reduce string variable memory requirements dramatically.

See DEFLEN, DIM and “String Variables” in this manual for more information about allocating memory for strings.

QUOTED STRINGS

Excessive use of quoted strings often occurs on larger computers because there is so much free memory. Shortening quoted strings may save memory. Also see ZBasic PSTR$ function for an extremely efficient way of utilizing string constants in DATA statements and in regular statements.

EFFICIENT CODE

Careful examination of source code may uncover ways to decrease code size by making repeated commands into subroutines or FN’s, or just cleaning up inefficiencies.

RAM DISKS

Some smaller computers allow the use of RAM disks. The Apple // ProDOS version for example, allows RAM disks up to 8 megabytes, while program and variable size are limited to 40K-50K. Utilizing a RAM disk to store indices, large arrays or whatever is nearly as fast as having that data in direct memory.

USE DISK INSTEAD OF MEMORY

If very large arrays or indices have been used in a large program you may have to store and access them from disk in a random file. This is slower than RAM access but is usually quite acceptable on most systems.

TEXT WIDTHS

Some computers have only 64 or 40 characters across the screen or 16 rows down the screen. You may have to adjust the program to accommodate this.

You should think about using the PRINT% or INPUT% commands if you plan on porting programs often. PRINT% puts text at ZBasics’ device independent graphic coordinates, not text column/row coordinates. This makes porting programs much simpler. Here are some typical character layouts:

COMPUTER	Columns (across)	Rows (down)
IBM PC and compatible	80 or 40	25
Apple // series	80 or 40	24
TRS-80 Model I, III	64 or 32	16
TRS-80 Model 4, 4p	80, 64 or 32	16 or 24
CP/M (typical)	80	24
Macintosh	Almost anything...	See appendix

PORTING PROGRAMS

CHARACTER SETS

Screen and printer characters vary form one computer to the next. Check the ASCII chart in the owners manuals to see the differences. (Most between 32-127 are the same.)

KEYBOARD, JOYSTICK AND MOUSE

Keyboards vary from computer to computer so be sure the target computer has the same keys available. If not, make changes in the program to use other keys.

Joystick and MOUSE devices vary considerably. Test the controls on the target computer and make adjustments for the hardware.

SOUND

Sound tone may vary from machine to machine. Check program and make any adjustments needed. Some machines may not have this capability at all.

DEVICE INDEPENDENT GRAPHICS

ZBasic makes use of very powerful and simple graphic commands that work the same way regardless of the graphic capabilities of the target computer (or lack of).

You will have to determine if the graphic hardware on the target computer is of sufficient quality to display the graphics of your program. Note: Colors and grey levels may have to be adjusted. Here are some of the typical graphic types available for some major computers:

COMPUTER	Horizontal x Vertical pixels
IBM PC and compatibles	CGA: 640x200 (3 color) or 320x200 (8 color)
	EGA: 640x348 (many colors)
	HERCULES and HERCULES PLUS: 720x348
	MDA: 80x25 (text simulation)
Apple //e, //c, //GS	Hi-Res 280x192 (6 color)
Apple //e,//c,//GS	Double Hi-Res 560x192 (16 color)
Macintosh	512,340 (larger monitors also supported)
TRS-80 Model I, III	128x48
TRS-80 Model 4,4p	160x72
	RS and Micro-Lab’s hi-res boards 640-240
CP/M-80 (typical)	80x24 (text simulation)
KAYPRO with graphics	160x100

MACHINE DEPENDENT SUBROUTINES

If the program being ported contains machine language subroutines, you will need to rewrite those routines in the machine language of the target computer. Watch out for:

DEFUSR	USR	OUT	INP
MACHLG	LINE	CALL	
PEEK	PEEKWORD	PEEKLONG	
POKE	POKEWORD	POKELONG	

Unless you completely understand the machine language of both the target and source computer, use extreme caution when porting programs with these commands.

PORTING PROGRAMS

MACHINE SPECIFIC COMMANDS

In order to take advantage of unique or special features of some computers, ZBasic offers special commands that will not work or function on others. Be sure the program you are porting contains only commands from the reference section of this manual.

Special ZBasic commands may have to be rewritten for the target computer.

Be sure to read the ZBasic appendices for both the Target and Source computers. They will explain in detail the special commands for each system (you must purchase a version of ZBasic for each computer you wish to compile from).

METHODS OF TRANSFERRING SOURCE CODE FROM ONE MACHINE TO ANOTHER

Telephone Modem Transfer

Transfer files using a Modem and simple communications software routines like the ones under OPEN"C" in the main reference section of this manual.

Serial (RS-232) Transfer

Transfer files over the Serial (RS-232) ports of the two computers using a good communication software package like Crosstalk or SmartCom. Crosstalk is available at computer or software stores nationally.

Diskette File Transfer Utility Programs

Use Diskette file transfer utility programs like Uniform or Interchange. These programs will convert a file from one disk format, like from a TRS-80 diskette to another disk format, like MS-DOS or CP/M. These programs are available from computer or software dealers nationally.

Re-type the Program

Type the program into the other computers. This may be acceptable for small programs but you will save plenty of time by using one of the options above.

See OPEN"C" in the reference section for a ZBasic terminal routine that may be used to transfer files.

Important Note: Always transfer files in ASCII. Tokens are not necessarily the same from one version of ZBasic to another and from old versions to newer versions on the same machine.

CONVERTING OLD PROGRAMS

CONVERTING OLD PROGRAMS

CONVERTING PROGRAMS WRITTEN IN OTHER VERSIONS OF BASIC

ZBasic is a very powerful and improved version of BASIC. Many of the traditional BASIC commands have been retained to make conversion as easy as possible. Nevertheless, ZBasic is not 100% compatible with every BASIC. You will have to make some changes to your old programs if you wish to convert them to ZBasic.

If file and graphic handling are not used, conversion will normally be very simple. If files or graphics are used the conversion will take a little more thinking. The following pages will give you important insights into making the conversion process as easy as possible.

The following pages will give you some ideas about converting your older BASIC programs. Following the paragraphs step-by-step will make conversion much easier.

SAVE YOUR OLD BASIC PROGRAM AS ASCII OR TEXT

Save your old BASIC program in ASCII or TEXT format so it can be loaded into ZBasic. ZBasic tokens are different from other BASIC tokens so loading them without first converting them to ASCII will make programs loaded look like random control codes or the wrong commands (if the program will load at all).

See the owners manual for the older BASIC to determine how to save in ASCII or TEXT format for your computer. The typical syntax is; SAVE “filename”,A.

Note: When upgrading to newer versions of ZBasic, programs may have to be saved in ASCII in the older version before loading into the newer version since tokens may have changed.

CONVERTING OLD PROGRAMS

CONFIGURING ZBASIC TO MAKE CONVERSIONS A LOT EASIER

ZBasic has been configured to give you maximum performance. When converting older BASIC programs this can be a problem. Often they are configured for ease of use instead of performance. ZBasic allows you to configure options so that converting your programs is simpler. Setting some of the options below will also make ZBasic more like BASIC you may be used to (like MSBASIC and BASICA).

Be sure to see “Configure” in the main reference section and in your appendix for details about other ways of configuring ZBasic.

To solve many of the problems encountered in converting we suggest setting the following options when converting other programs. Be sure to set these options BEFORE LOADING your program:

CONFIGURE OPTION	SET TO
1. Double precision digits of accuracy	6 or 8
2. Single precision Accuracy	4 or 6
3. Array bounds checking Y/N	Y
4. Default Variable type <S>ingle, <D>ouble, <I>nteger	S
5. Convert to Uppercase Y/N	Y
*6. Optimize expressions for Integer Y/N	N
*7. Spaces Required between Keywords Y/N	Y

1. Since ZBasic does all floating point operations in double precision, it is important to configure ZBasic for the speed and accuracy that you need. In most cases the configuration above will be suitable (but not in all cases). If you wish disk files and memory requirements to be the same as MSBASIC leave the digits of accuracy at 14 and 6 as they take up 8 bytes of Double and 4 bytes for single (the same as MSBASIC).

2. Set to two digits less than Double precision.

3. Sets array bounds checking to give runtime errors. Set to “N” when your program is debugged.

4. Set to Single (S) if you want code to be most like other BASICs. We highly recommend you set it to integer if possible. Integer will often increase program speeds 10 to 100 times.

5. Setting allows variables like “Fred” and “FRED” to be the same variable. If you want CASE to be significant, do not change the configuration.

6. ZBasic gives you two options for deciding how expressions may be evaluated. ZBasic defaults to optimizing expressions for Integer to get the fastest and smallest code. Most other languages do not. Set to “N” for easier conversions. See “Math” for explanation of ZBasic options for expression evaluations.

7. Some BASICs allow using keywords in variables (like INTEREST). To allow this, spaces or other non-variable type characters are required around keywords. Set this for easier conversion in most cases (especially IBM PC and Macintosh BASIC type programs).

*Note: Not available on all versions of ZBasic.

CONVERTING OLD PROGRAMS

CONVERTING RANDOM FILES

ZBasic incorporates FIELD, LSET, MKI$, MKS$, MKD$, CVI, CVS and CVD into the READ and WRITE statements saving the programmer a lot of time. RECORD is used instead of GET and PUT for positioning the file pointer.

The OPEN and CLOSE statements are the same for both BASICs except for MSBASIC use of OPEN FOR RANDOM type. This is changed easily.

ZBASIC statements	MSBASIC equivalents
OPEN”R”	OPEN”R” or OPEN FOR RANDOM
READ, WRITE, RECORD	FIELD, GET, PUT, LSET, RSET, CVS, CVD, MKS$, MKD$,CVI, MKI$

Note: While ZBasic also supports MKI$, CVI and MKB$, CVB, they are not necessary for use n Random files since ZBasic’s READ and WRITE automatically store and retrieve numeric data in the most compact format (ZBasic’s MKI$, CVI, MKB$ and CVB are most useful for condensing numbers for other reasons). Since ZBasic allows using any variable type in READ and WRITE statements, the user is not faced with complicated conversions of strings-to-numbers and numbers-to-strings.

CONVERTING SEQUENTIAL FILES

Most ZBasic Sequential file commands are very similar or the same to MSBASIC.

ZBASIC statements	MSBASIC equivalents
OPEN”I” or OPEN”O”	OPEN”I”, OPEN”O” or OPEN”A” or OPEN FOR INPUT,
OPEN”A” some versions	OUTPUT or APPEND some versions
EOF(n) some versions	EOF(n) some versions
LINEINPUT, INPUT, PRINT	LINEINPUT,INPUT,PRINT

Note: The biggest difference when converting sequential file statements is that ZBasic’s PRINT# statements should have quoted commas:

```
MSBASIC:  PRINT#1,  A$,B$,C$     or      PRINT#1, A$ B$ C$
ZBASIC:   PRINT#1, A$”,”B$”,”C$
```

DISK ERROR TRAPPING

ZBASIC statement	MSBASIC equivalent
ON ERROR GOSUB	ON ERROR GOSUB

Read “ON ERROR” and “Disk Error Trapping” in this manual for detailed information. ZBasic error codes are much different from MSBASIC.

Important Note: ZBasic does not necessarily store data in disk files in the same way or format as other versions of BASIC. You may have to convert existing BASIC files to ZBasic format.

CONVERTING OLD PROGRAMS

CONVERTING GRAPHIC COMMANDS

ZBasic's Device Independent Graphics are very powerful and simple to understand. Conversion should be painless in most cases:

ZBASIC GRAPHICS	**MSBASIC equivalent**
PLOT	LINE,PSET,PRESET
CIRCLE	CIRCLE
BOX	LINE (with parameters)
COLOR	COLOR (PSET, PRESET black and white)
MODE	SCREEN
POINT	POINT
GET, PUT (some systems)	GET, PUT (some systems)
RATIO	aspect parameter of CIRCLE
FILL	PAINT
PLOT USING	DRAW

ZBasic defaults to a relative coordinate system of 1024x768. This system does not pertain to pixels but to imaginary positions on the screen. Most older versions of BASIC use pixel coordinates.

Macintosh and MSDOS: Use COORDINATE WINDOW at the beginning of program to set a program to pixel coordinates. Apple: See appendix for ways of using POKE to set system to pixel coordinates.

LOOP PAIRS

All ZBasic FOR-NEXT, WHILE-WEND and DO-UNTIL loops must have matching pairs. Some BASIC interpreters allow the program to have two NEXTs for on FOR, or two WENDs for one WHILE. Since ZBasic is a compiler it will not allow this. A STRUCTURE ERROR will be generated when you compile a program with unmatched LOOP pairs.

Another way to find unmatched pairs is to LIST a program. Since ZBasic automatically indents loops, just read back from the end of the LISTing, looking for the extra indent, to find the unmatched statement.

COMPLEX STRINGS

Complex strings may have to be converted to simple strings (some machines).

Improper	B$=LEFT$(Right$(A$,12), 13)
Proper	B$=RIGHT$(A$,12): B$=LEFT$(B$,13)

IF-THEN statements may have only one level of complex string.

Improper	IF B$=LEFT$(A$,5) THEN GOSUB "END"
Proper	C$=LEFT$(A$,5): IF B$=C$ THEN GOSUB "END"

CONVERTING OLD PROGRAMS

LONG LINES

Multiple statement lines with over 253-256 characters (depending on computer) will automatically be shortened by ZBasic when loading. That part of the line longer than 253 will be added to a new line number. Most programs do not have lines of that length.

TIMING LOOPS

Timing loops may have to be lengthened to make up for ZBasic's faster execution time. For some BASIC Languages a FOR-NEXT loop of 1000 would take second or two. (About 1/1000 of a second in ZBasic!) Replace these types of delay loops with the ZBasic DELAY statement.

STRING MEMORY ALLOCATION

Important Note: ZBasic assumes a 255 character length for every string and string array element and allocates 256 bytes for each (255+1 for length byte) unless string length is defined with DIM or DEF LEN.

Many versions of BASIC, like BASICAtm, MSBASICtm, APPLESOFTtm and others, allocate string memory as a program needs.

While this may seem efficient on the surface, immense amounts of time are wasted in "String Garbage Collection". Garbage Collection is what happens when your program suddenly stops and hangs up for two or three minutes while BASIC rearranges strings in memory. This makes this method unusable for most serious programming.

HOW DIMMING STRING ARRAYS AFFECT PROGRAM CONVERSION

MSBASIC™:	CLEAR 10000	Sets aside 10,000 bytes for ALL strings
	DIM A$(1000)	Uses memory allocated with CLEAR plus 3-8 byte pointers per element.
ZBASIC™:	DIM A$(1000)	256,256 bytes allocated (100x256)
ZBASIC™:	DIM 10 A$(1000)	10,010 bytes allocated (1001x10)

Many BASICs use CLEAR to set aside memory for strings. Each string in ZBasic is allocated memory at compile time.

A problem you may encounter while converting: Out of Memory Error from DIMension statements, like the ones above (just define the length of the string elements).

ZBasic allows you to define the length of any string with DEFLEN or DIM statements. Check the string requirements of the program you wish to convert and set the lengths accordingly.

If you have large string arrays that must have elements with wide ranging lengths (constantly changing from zero to 255 characters), use ZBasic's special INDEX$ string array. Like other BASIC's CLEAR is used to set aside memory for this array (no "Garbage collecting" here either).

See INDEX$, DEFLEN, DIM and "String Variables" for more information.

CONVERTING OLD PROGRAMS

OTHER INFORMATION

Check your appendix for more information about converting programs.

A good resource for information about converting from one version of BASIC to another is David Lien's "The BASIC Handbook".

CONVERTING OLD COMMANDS

Some BASIC(s) have commands that may be converted over quickly using a word processing program. Simply load the BASIC ASCII file into the word processor and use the FIND and REPLACE commands. (You may also use ZBasic FIND command if you choose.)

A good example would be converting Applesofttm's HOME commands into ZBasic's CLS command. Have the word processor FIND all occurrences of HOME and change them to CLS.

If you don't have a word processor try using this simple ZBasic convert program to change commands in a BASIC file quickly (file MUST have been saved in ASCII using SAVE*).

SINGLE COMMAND CONVERSION PROGRAM

```
ON ERROR GOSUB "DISK ERROR": REM Trap Disk Error
INPUT"Command to Change:";Old$
INPUT$"Change to:";New$
CLS: PRINT" Changing File....One Minute please"
OLDFILE$="oldfile":NEWFILE$="newfile":  REM  <-- Change to correct filenames
OPEN"I",1, OLDFILE$
OPEN"O",2, NEWFILE$
WHILE ERROR=0
  LINEINPUT#1, Line$
  DO
    Line$=LEFT$(Line$,I-1)+New$+RIGHT$(Line$,LEN(Line$)-I+1+LEN(Old$))
    I=INSTR(1, Line$, Old$)
  UNTIL I=0
  PRINT#2, Line$
WEND
"Done changing"
ERROR=0
CLOSE
PRINT "All '";Old$;"' have been converted to '";New$;"'"
INPUT"Rename OLD file? Y/N: ";A$:   A$=UCASE$(A$)
IF A$="Y" THEN KILL OLDFILE$
RENAME "NEWFILE" TO OLDFILE$
END
"DISK ERROR"
PRINT ERRMSG$(ERROR)
CLOSE: STOP
```

Important: Practice on a dummy file until you are sure the program is working properly.

KEYWORDS

STANDARD STATEMENTS, FUNCTIONS AND OPERATORS

- ABS
- AND
- ASC
- ATN
- BIN$
- BOX
- CALL
- CHR$
- CIRCLE
- CLEAR
- CLOSE
- CLS
- COLOR
- COS
- CVB
- CVI
- DATA
- DATE$
- DEF
- DEFDBL
- DEFINT
- DEFSNG
- DEFSTR
- DELAY
- DIM
- DO
- ELSE
- END
- ERRMSG$
- ERROR
- EXP
- FILL
- FIX
- FN
- FOR
- FRAC
- GOSUB
- GOTO
- HEX$
- IF
- INDEX$
- INDEXF
- INKEY$
- INP
- INPUT
- INSTR
- INT
- KILL
- LEFT$
- LEN
- LET
- LINE
- LOC
- LOCATE
- LOF
- LOG
- LONG
- LPRINT
- MACHLG
- MAYBE
- MEM
- MID$
- MKB$
- MKI$
- MOD
- MODE
- MOUSE
- NEXT
- NOT
- OCT$
- ON
- OPEN
- OR
- OUT
- PAGE
- PEEK
- PLOT
- POINT
- POKE
- POS
- PRINT
- PSTR$
- RANDOM
- RATIO
- READ
- REC
- RECORD
- REM
- RENAME
- RESTORE
- RETURN
- RIGHT$
- RND
- ROUTE
- RUN
- SGN
- SIN
- SOUND
- SPACE$
- SPC
- SQR
- STEP
- STOP
- STR$
- STRING$
- SWAP
- TAB
- TAN
- THEN
- TIME$
- TO
- TROFF
- TRON
- UCASE$
- UNS$
- UNTIL
- USING
- USR
- VAL
- VARPTR
- WEND
- WHILE
- WIDTH
- WORD
- WRITE
- XELSE
- XOR

IMPORTANT: See your computer appendix for other keywords that pertain to your version of ZBasic. Most versions of ZBasic offer more and also use two-word keywords like LONG FN, POKE WORD etc.

KEYWORDS

STANDARD COMMANDS

APPEND
AUTO
DELETE or DEL
DIR
EDIT, E or comma “,”
FIND or semicolon “;”
HELP
LIST, L or period ”.”
LLIST
LOAD
MEM
MERGE
NEW
QUIT
RENUM
RUN
SAVE