MacFORTH®

A High Performance
Interactive Programming
Environment for the
Apple Macintosh® Computer

Level One

CREATIVE SOLUTIONS

Problem Solving for Business and Computer Applications

MacFORTH™

User and Reference Manual

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Acknowledgments:

Portions of this document are derived and sometimes directly copied from the documentation provided to the authors by Apple Computer, Inc. This has been done to ensure technical accuracy, and is used with their permission.

This document was entirely prepared and produced on a Macintosh™ under MacWrite™. All output was produced on an Imagewriter™ printer.

MacFORTH was designed by Don, Dave, and Steve; implemented by Don and Dave; and documented by Dave, Don, Richard, Chris,and Tara.

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Creativity is more than just being different...
Anybody can play weird -- that's easy.

What's hard is to be as simple as Bach.
Making the simple complicated is commonplace...
Making the complicated simple
-- awesomely simple;

That's creativity.

-- Charles Mingus, jazz musician (1922-1979)

The MacFORTH project is dedicated to Alexander Ramsay, and proudly bears the Ramsay tartan on its cover. In his 90th year, he is a continuing source of inspiration for the road ahead.

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Introduction

To

MacFORTH™

WELCOME! We are about to make what you do with a computer more fun. We'll do it by making you more productive with results that are easier to attain. The Apple Macintosh™ (or more fondly 'Mac') represents a revolution in the way that people interface to computers. Few computer users who have experienced the Mac's graphics, windows, menus, or mouse will choose to go back to the same old alpha screen and keyboard interface.

In order to provide a consistent user interface across all applications, Apple has included a large amount of software features in read-only memory (ROM) built into every Macintosh. MacFORTH has been specifically tailored to put these functions at your disposal.

Regardless of your prior programming experience, you will find writing programs for the Macintosh to be a new and exciting experience. The objective of this manual and the MacFORTH product is to equip you with the necessary tools to write programs which fits comfortably within the Macintosh environment.

Learning how to effectively use the Macintosh is in many ways similar to learning FORTH. Each is based on extensions to a small set of simple concepts. Each requires you to re-orient your approach to computer related applications, and both provide better results with less effort.

In order to learn how to use the Macintosh, you will first learn how to write programs in MacFORTH, and then how to use such programs to interface to the Macintosh.

We have included a Computer Aided Instruction Course called "Going FORTH". The course is designed to start novice FORTH users and programmers solving problems with MacFORTH. Even if you are an old hand at FORTH, go through the course to review some of the basics of MacFORTH and the Macintosh.

Creative Solutions has been producing 68000 based FORTH systems since 1979. The MacFORTH product is a derivative of our Multi-FORTH™ product line, specifically tuned to take maximum advantage of the Macintosh features and facilities.

CSI 68000 FORTH Products have been used to solve problems across a wide spectrum of applications:

Airborne Radar Systems
AT&T Circuit Analyzers
General Accounting Systems
Video Games
Nuclear Power Plant Pipe Testers
Spread Sheet Programs
Data Base Managers
Hospital Operating Room Patient Monitoring
and some of the world's largest ROBOTS

The MacFORTH product line is divided into three areas:

Level I

For the hobbyist or those just getting started with the Macintosh. The Level 1 product has been designed to put the tremendous power of the Macintosh at your fingertips, without your having to know a lot about programming or computers. This and all levels of the MacFORTH product line provide stand-alone programming capabilities with the Mac, with trace, debug and toolbox access. The serial interface and sound synthesizer are also supported.

Level II

For the Professional who will be using MacFORTH in her/his work. The Level 2 product includes many enhancements such as more advanced graphics commands, a full 68000 in-line assembler, floating point, and more documentation allowing further access to the toolbox. It is specifically designed to meet the needs of the professional user.

Level III

For software developers thinking of either converting existing programs to run on the Mac or developing new programs. Level 3 allows you to do all of your program development on the Mac, and then generate run-time only versions of your product (contact CSI for details on royalties and other arrangements). This version includes support from CSI, additional documentation and 250 "right to execute" licenses.

The Macintosh: An Appliance Computer

The Macintosh is intended to be the first mass-market personal computer. It is designed to appeal to an audience of non-programmers, including people who have traditionally feared and distrusted computers. To achieve this goal, the Macintosh must be friendly; it must dispel any notion that computers are difficult to use. Two key ingredients combine in making a system easy to use: familiarity and consistency.

Familiarity means the user easily understands and is comfortable with what is expected of her or him at all times. Most Macintosh applications are oriented towards common tasks: writing, graphics and paste-up work, ledger sheet arithmetic, chart and graph preparation, and sorting and filing. The actual environment for performing these tasks already exists in people's offices and homes; we mimic that environment to an extent which makes users comfortable with the system. Extensive use of graphics plays an important part in the creation of a familiar and intuitive environment.

Consistency means a uniform way of approaching tasks across applications. For example, when users learn how to insert text into a document, or how to select a column of figures in one application, they should be able to take that knowledge with them into other applications and build upon it. Uniformity and consistency in the user interface reduces frustration and makes a user more at ease with the task at hand.

Years of software development, testing, and research have gone into the definition of the Macintosh user interface. On many other computers, since little or no user interface aids are built in, each applications programmer invents a new and original interface for each program. This leads to many different (and usually conflicting) interfaces.

Apple has attempted to avoid this situation on Macintosh by building tools for a versatile, well-tested user interface and placing them in ROM to be used by all application programs. There's no strict requirement that an applications program must use any or all of the supplied interface tools; but programmers who create their own interface do so at the expense of their own development time, useable data space, and the overall consistency of the application.

MacFORTH is able to directly access the built-in toolbox functions. Since the toolbox has been designed for general applicability, often the amount of set-up required to perform even a simple function (like adding a window or menu item) is extensive. We have factored out the most common functions (menu, window, mouse, and file operations) and provided you with clear and simple FORTH operators which make them easy to use.

MacFORTH:

A High Performance, Interactive Programming Environment

FORTH is a language, but it is also a tailorable operating system and a set of tools for developing and debugging your programs interactively. Since FORTH is all of these things at once, it has been accurately described as a "programming environment".

We feel that FORTH matches the process of human thought more closely than any other programming method. Defining your own commands as you go along, and using these commands in defining further commands, you actually create your own personalized programming environment that is natural to the way you think.

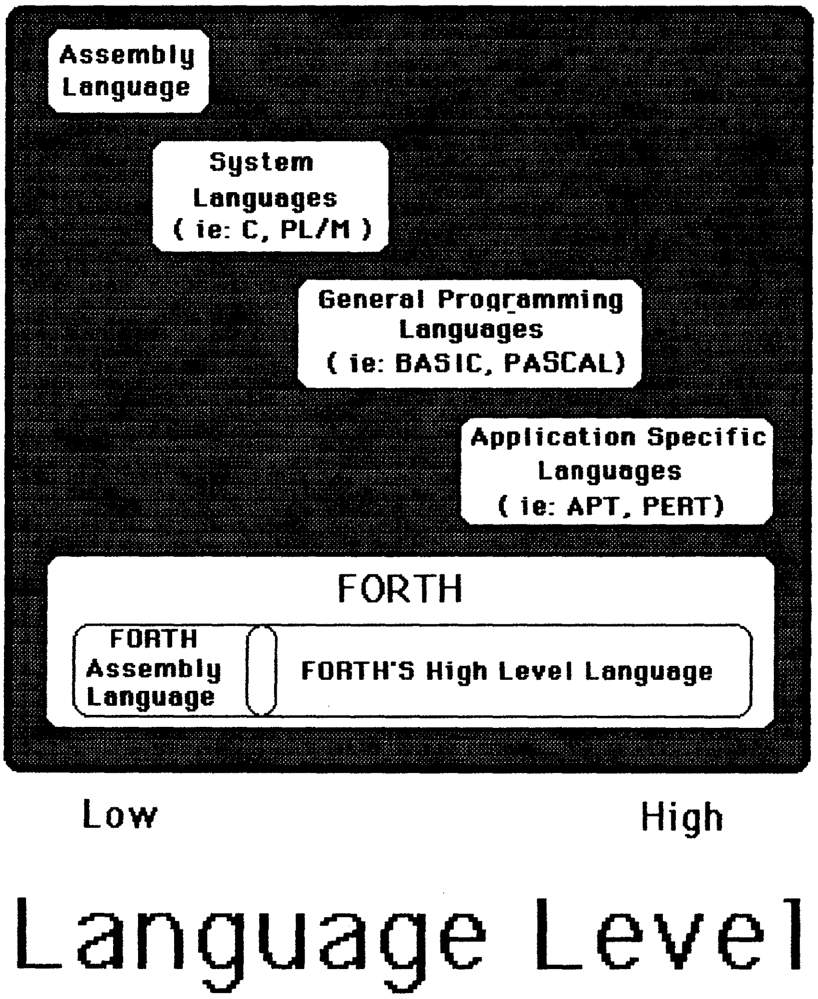
FORTH gives you as much or as little control over the computer as you want, at any level -- from the most powerful application commands down to the machine code instructions. Figure i-1 illustrates the various levels at which comparable programming languages operate.

Philosophically, FORTH takes a substantially different approach to developing computer applications from other languages and operating systems. Most other programming systems were designed to teach students how to solve simple, self-contained problems on large timesharing or batch mainframe computers. FORTH was developed specifically by and for the use of scientific and engineering professionals in the solution of difficult real time data acquisition and process automation problems. Since its inception over ten years ago, FORTH has been hammered into its current form on the hard anvil of actual applications experience. What has emerged is a system which encourages competence and technical responsibility by the user and delivers unbridled performance.

MacFORTH is a very powerful 32-bit implementation of FORTH which includes the traditional features of FORTH as well as many new innovations.

MacFORTH puts the power of the computer in your hands. If you choose to execute an endless loop or overwrite your program with data, MacFORTH will not stand in your way. Consider the analogy of a power saw. The saw substantially reduces the time required to cut a piece of wood to a desired size. It does not protect you however, from cutting in half the sawhorse on which the board rests. Avoiding such an obvious error is your responsibility. Consider the cost of a saw which was able to detect sawhorses and turned itself off whenever it encountered one. This is similar to the tremendous overhead involved in many "traditional" computer languages.

While using MacFORTH, you will occasionally cause an error which will require a restart of the system (for example the "bomb" alert box). This is the natural result of the learning process. As you become more proficient, this will occur less frequently.



Assembly Language
System Languages (ie: C, PL/M)
General Programming Languages (ie: BASIC, PASCAL)
Application Specific Languages (ie: APT, PERT)
FORTH
FORTH Assembly Language
FORTH'S High Level Language
Low
High
Language Level

Figure i-1

Iterative Organization

The oldest programming approach was simply to write code until you finished. Later the fashion was to organize a program into "modules", then to code each of the modules. This approach was named "top down design", and the older approach was dubbed "bottom up".

FORTH uses a still newer approach. Modularization is part of the method, but the "modules" (or skeletal versions of the modules) are actually coded and tested at the same time they are designed. You can code a "sketch" of the applications, and test to see if your general solution to the problem is correct. If not, you simply rewrite the simple outline, and continue testing until you're satisfied. Then you can "flesh out" the outline with more detail.

This process is called "iterative development." On each iteration you solve the problem at a deeper level and gather information necessary to avoid problems at the next lower level. If you reach a point where insufficient information is available, it is easy to interactively explore alternative approaches, selecting the best solution at that level.

We have utilized a similar approach in this manual. The manual is divided into two main sections: the User's Guide and the Reference Guide. The beginning chapters of the User's Guide show you to how to interact with MacFORTH: creating, editing and saving. Later chapters of the User's Guide walk you through successively more comprehensive examples, building on previously developed skills and introducing the MacFORTH interface to each of the major Macintosh features and facilities.

The reference guide provides in-depth discussion of the MacFORTH interface to each of the following Macintosh features: Menus, Windows/Events, the File System, and the Printing/Serial Interface. We also discuss some advanced topics, the error handling used by MacFORTH, and provide a glossary of all words in the system (words which are provided in source form -- like the editor -- are not included in the glossary).

We hope our approach makes learning MacFORTH easy. We know you'll be happy with the results.

We actively solicit any comments in reference to the form, content, or accuracy of this manual. Your responses will allow this documentation to evolve to better meet the needs of our customers. Please send your comments to:

> MacFORTH Product Manager
> Creative Solutions, Inc.
> 4701 Randolph Road, Suite 12
> Rockville, MD 20852
> 301-984-0262

Chapter 1: Installation

Overview

This chapter will show you how to install MacFORTH™ on your computer. It will also discuss the files found on your MacFORTH system disk.

License Agreement

Before opening the package which contains the MacFORTH System Disc, carefully read the License Agreement on the cover of the package. Briefly, it states . . .

> MacFORTH, including this manual and supplied diskette and contents of both, is owned exclusively by Creative Solutions, Inc. A copyright is registered with the United States Copyright Office, for both the manual and the accompanying object code. After paying the license fee, agreeing to the terms of the license agreement, and returning the attached registration card, you are licensed to use MacFORTH on a single computer system.
>
> You may not provide copies of CSI supplied materials to anyone else for any reason. If you transfer your right to use MacFORTH to anyone else, you are then no longer licensed to use it yourself.

We're quite serious about this. The MacFORTH product is the result of an enormous amount of work. We have foregone any hardware copy protection scheme <u>for your convenience</u> ; we simply encode a serial number on each disk. This allows you to always have a backup in the event of a media or hardware failure and allows us to trace the source of illegal copies. We feel that we have produced an outstanding product for the price, and that our customers will respect our efforts and the law by adhering to these terms.

If the cover to the manual that you are reading does not include the distinctive MacFORTH red, white and black logo, you are utilizing a copy which was produced in violation of US copyright laws. Contact your attorney for instructions on how to return this illegally produced material to Creative Solutions.

Be sure you make a backup of your MacFORTH system disk <u>before</u> you use the system!

Making a Backup

Be sure to write protect your original MacFORTH disk before you make a backup. This is described in your Macintosh System documentation (on page 89 - "Locked Disks"). Place the MacFORTH disc in your drive and follow the instructions in your Macintosh System documentation (on page 81 - "Copying an Entire Disk"). When you have made a backup, store the original disk in a safe place and use your backup disk. This will protect you in the event of a disc related error.

Loading MacFORTH

<u>Before</u> you just start experimenting with the system, you should proceed through this manual, trying each example. Feel free to try other examples of your own as the topics are being presented. The Macintosh is like **no** other computer. There are many unique features you need to know about to make the best use of this new computer. You can avoid most common mistakes and misunderstanding by just working your way through the entire manual the first time you use the system.

When you are ready to load MacFORTH, place the MacFORTH system disk in the drive and reset your computer (either press the programmer's reset button, or turn the computer off, then back on).

<u>Loading the MacFORTH System</u>
To load the MacFORTH system (which loads MacFORTH and the editor), double click on either the "MacFORTH" icon or the "FORTH Blocks" icon. "FORTH Blocks" is a MacFORTH document and will load the MacFORTH sytem first, then load the source code contained in the "FORTH Blocks" file itself. When you double click "MacFORTH" it automatically loads the "FORTH Blocks" file.

The MacFORTH window will appear and you will see the soon-to-be-familiar "ok". The arrow cursor will turn into a wristwatch, indicating you should wait while the system is extended to include the editor (you will notice that whenever source code is loaded from disk, the cursor will turn into a wristwatch temporarily). Finally, you will be asked to enter your initials (this is for the editor and is explained in more detail in the "Program Editing" chapter). Enter your first, middle, and last initials.

Loading Only MacFORTH

If you want to load the MacFORTH system itself, without the editor or any other "extras", edit block 1 of the "FORTH Blocks" file and delete (or comment out) any commands which load other code (editing a block will be explained in detail in the Program Editing chapter).

Setting MacFORTH as the "Startup" File

Finder 1.1 (the current level of the Macintosh operating system) allows you to select a file to be automatically loaded when the computer is reset (or turned on). To select MacFORTH as the auto-load file, from the Finder, select the "MacFORTH" icon (it will become inverted), and then select the "Set Startup" item from the "Special" menu. To verify that MacFORTH will be automatically loaded, turn your computer off then on and watch MacFORTH load.

Loading the MacFORTH Demos

The demos provide a few graphic and music examples for your amusement as well as examples of MacFORTH source code. To load the demos from the Finder, double click on the "Demo Blocks" file. To load the demos from MacFORTH, execute the phrase

```
      INCLUDE" Demo Blocks"
```

By the time you have completed the Users Guide section of this manual, you will have an understanding of how to write programs similar to the demos.

To select the demo you like, activate its window (by clicking the mouse down inside its window) or pull down the music menu. You can see the source code for the demos by simply editing or printing the "Demo Blocks" file (as described in the Program Editing chapter).

We provide the source code to the demos for you to use as examples. Feel free to modify the code for the purpose of experimentation. We discuss how to do this in the Editing chapter.

The demos provided are:

1.) Approach
Spins in the MacFORTH logo. Shows the rotation and scaling features of the MacFORTH graphics package.

2.) Clock
Displays the current time (as read from the internal clock) in the format of an analog clock. Shows real time update of the window. You can change the size of the clock by resizing its window.

3.) Dark Beams
Displays a series of lines which can create some facinating results. Try resizing the window.

4.) Bouncer
Displays a bouncing ball in the window. Resize the window for different bouncing patterns.

5.) Spirals
Displays some geometric doodling. Shows the speed and power of the MacFORTH graphics package. The code for this demo fits easily in one block of source code.

6.) Sound
Plays Bach's Two Part Invention #8.

Contents of the MacFORTH System Disk

In case you're wondering what each of the files on the disc are:

1.) "MacFORTH"
Contains the MacFORTH system itself. When opened from the Finder (by double-clicking or the Open item of the File menu) MacFORTH is loaded. It then loads the "FORTH Blocks" file.

2.) "FORTH Blocks"
MacFORTH blocks file which contains the source code for some useful utilities. It is loaded to extend the MacFORTH system. Modify block one of this file if you want to load your application automatically when MacFORTH is loaded.

3.) "Going FORTH"
MacFORTH blocks file which contains the source code for the Going FORTH tutorial. Double-click on this file to load the computer-aided instruction course.

4.) "GF Data"
Contains the text used in the Going FORTH tutorial.

5.) "Demo Blocks"
MacFORTH blocks file which contains the source code for the demos. Double click on this icon to load just the demos.

6.) "MacFORTH Folder"
A Mac folder used to hold files used by MacFORTH. The Finder and system are contained in this folder to avoid cluttering up the screen.

7.) "More Examples"
A MacFORTH blocks file containing examples in source form.

You may want to delete the "Going FORTH", "GF Data", and "Demo Blocks" files on your backup disc for more space.

MacFORTH Customer Support Hotline: (301) 984-3530

We have established the "MacFORTH Hotline" to assist you with questions and/or problems you have concerning the MacFORTH product. Help is available between the hours of 1 p.m. and 5 p.m. Eastern Standard Time, Monday thru Friday at (301) 984-3530 on a first-come-first-served basis.

The following guidelines have been established for the MacFORTH Hotline:

1.) Only MacFORTH customers who have signed and returned their registration cards may use the MacFORTH hotline. If you haven't signed and returned your card (the one attached to the disk envelope) yet, **do it now**.

2.) Know your serial number (its on the original MacFORTH disk you received). You need to tell the person answering the hotline your name and disk number before you can ask your questions.

3.) Have your questions written down in front of you. We allow a maximum of 5 minutes per call when others are waiting. This is ample time to answer even a long list of questions if they are clear and written down.

4.) Please don't use the hotline for marketing questions. This is for technical support only.

We are happy to support valid, registered users who have questions about MacFORTH.

You can also direct any questions/comments/suggestions in writing to:
MacFORTH Product Manager
Creative Solutions, Inc.
4701 Randolph Road, Suite 12
Rockville, MD 20852

Chapter 2: Going FORTH

Overview

This chapter provides the instructions for running the Going FORTH computer aided instruction course which is supplied on the MacFORTH system disc.

The tutorial is designed for everyone. The novice FORTH programmer will learn the basics of FORTH, more experienced FORTH programmers will get a flavor for running MacFORTH on the Macintosh.

It is important that you run through the course, as many Macintosh specific terms are introduced there. **We will assume you have run the course and use these terms throughout the manual.**

Preparation

To run the course, power up your Macintosh with the MacFORTH system disc in the drive. Open the "Going FORTH" document (by double clicking in it). While it is loading, you will get the message "Loading the Going FORTH Tutorial." Be sure you read this chapter before you begin the course (and remember to re-size the window).

Once the course is loaded, you need to shrink the size of the MacFORTH window by dragging its size box over to the left. Figure 2.1 shows what your screen should look like while running Going FORTH.

Running the Course

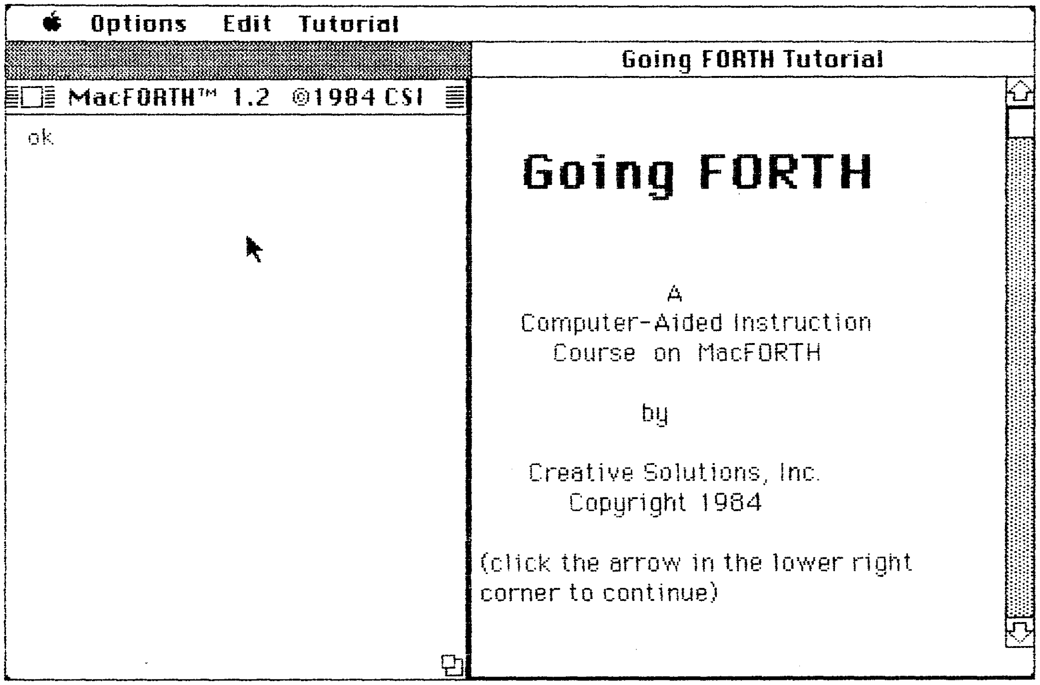
When you uncover the Going FORTH window, the course will start automatically, displaying the first frame. On the right hand side of the window you will notice the scroll bar. To move on to the next frame, click the arrow in the lower right side of the window. To review previous material, click the arrow in the upper right side of the window.

To move from chapter to chapter, click the mouse down in the shaded area above or below the scroll box (the scroll box is the white box in the shaded area of the scroll bar). You can also move the scroll box to any position within the course by dragging the scroll box up or down.

If you press any keys while in the Going FORTH window, the Mac will beep at you, reminding you that you can only enter keystrokes in the MacFORTH window while you are completing the tutorial.

If you close the Going FORTH window, you can re-enter the course by selecting the "Going FORTH" item from the "Tutorial" menu.

That's it! That's all you need to know; the tutorial will give you any additional instructions you need, now get going FORTH!



ok

Going FORTH

A
Computer-Aided Instruction
Course on MacFORTH

by

Creative Solutions, Inc.
Copyright 1984

(click the arrow in the lower right corner to continue)

Figure 2.1

Stopping and Restarting the Course

If you don't complete the course in one sitting, restarting where you left off is easy. To leave the course, make a note of where you are in the course (the chapter and page), and select the "Exit MacFORTH" item from the "Options" menu. When you want to restart where you left off, run the course (as described in "Running the Course" in this chapter) and move the thumb down until you find where you left off.

Chapter 3: Program Editing

Overview

This chapter introduces you to one of the most used features of MacFORTH, the editor. Using the editor, you can create and save your programs on disc. This allows you to create and modify program source code without retyping it each time you load the system. The MacFORTH editor uses an editing technique similar to MacWrite, so if you are familiar with MacWrite, you will be right at home using the MacFORTH editor.

The MacFORTH editor is used to edit program source files on the disc. We will introduce some of the file system commands you will use normally with the editor. For an in-depth discussion of the file system and its commands, refer to the File System chapter.

Preparation

To start this session load the MacFORTH system by resetting your Macintosh (power off then on or press programmers reset button on the left side of your machine) . With your MacFORTH disc in the drive, double click on either the "MacFORTH" or the "FORTH Blocks" file in the window that appears on your screen (if you have set the MacFORTH file as the startup file, MacFORTH will be loaded automatically). When this file loads, it also loads the editor from the file "Editor Blocks" automatically. (Remember to enter your initials when asked.)

We'll stress again the importance of the editor to your effectiveness with MacFORTH and urge you to spend the time **now** to understand how it works. Try each example in this chapter <u>before</u> continuing.

Be sure to restart your computer as instructed above so that the examples in this chapter make sense.

Selecting a File for Editing

When you loaded MacFORTH from the Finder (if you don't know what the Finder is, refer to your Macintosh manuals), MacFORTH assigned the file "FORTH Blocks" to file number 0, opened it and selected it as the current "blocks file". The MacFORTH editor allows you to edit the current "blocks file" only. (File assignment, opening, selection and file numbers are discussed in more detail in the File System chapter. For now, just execute the examples to practice using the editor.)

Displaying File Assignments

You can see what files are assigned and opened by executing:

```
            ?FILES
```

You can see that "FORTH Blocks" is assigned to file number 0, that it is open (by the capital "O"), and that it is the current "blocks file" (by the capital "B").

Since the "FORTH Blocks" file is the file you are going to work with in this chapter, you don't need to do anything else to continue. For future reference, we will discuss how to select a different file for editing.

Using a Different File to Edit

If you want to use a different file for editing, execute the **USE"** command in the following format:

```
            USE" <file name>"
```

USE" assigns the file specified by the name <file name> to the first available file number, opens it, and selects it as the current blocks file for editing (if it is a blocks file). For example, to specify the MacFORTH demos source file for editing (contained in the file "Demo Blocks"), execute:

```
            USE" Demo Blocks"
```

Selecting a Different File to Edit

Once a file has been opened (via the **USE"** command, for example), you can re-select it as the file to edit with the **SELECT** command. **SELECT** is used in the following format:

```
            <file number> SELECT
```

For now, you just want to edit the program source code contained in the file assigned to file number 0 (the "FORTH Blocks" file), execute:

```
            0 SELECT
```

SELECT acts on a file which has already been assigned a number. **USE"** should be used when that file has not yet had a number assigned to it (ie. the first time you use the file after entering MacFORTH).

Entering the Editor

There are three ways to enter the editor:

1.) Execute the **EDIT** command in the following format:

```
<block#>  EDIT
```

Try:

```
5 EDIT
```

Then exit the editor by clicking in the MacFORTH window.

2.) Activate the editor window by clicking in it with the mouse.

3.) Pull down the "Edit" menu and select the "Enter Edit" item (or execute its equivalent keystroke, ⌘E).

Exiting the Editor

There are three ways to exit the editor:

1) Pull down the "Edit" menu and select "Exit Editor" item (or execute its equivalent keystroke, ⌘E) .

2) Click in another window with the mouse.

3) Close the editor window by clicking in its close box.

Block Buffers

When a block is edited, it is read from disk into memory. The area of memory it is kept in during the editing process is called a "block buffer". Each time a change is made to the block, it is modified in the block buffer <u>only</u>. When you exit the editor, or select another block to edit, data in the block buffer is then written to disk.

Using the Editor

The files you will edit are called "block files" because they are made up of a sequence of "blocks" (old-time FORTH programmers may prefer the term "screens"). A block is the fundamental unit of disc storage used by MacFORTH. It is simply a fixed length record containing 1024 characters for programs. The "FORTH Blocks" file on the MacFORTH system disc contains the source code for some MacFORTH utilities, as well as empty space for your use.

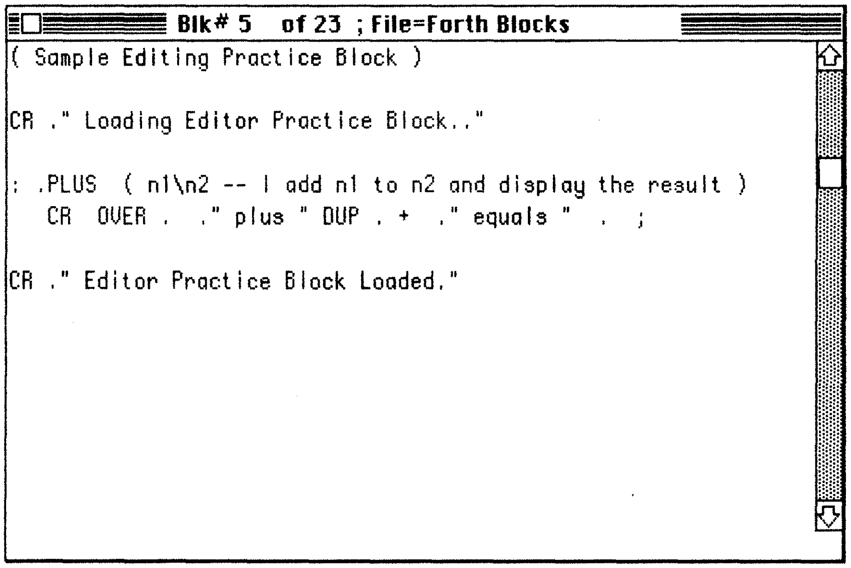
You should organize your program source code logically into files by categories. For example, you can see that we put the MacFORTH utilities in the "FORTH Blocks" file, the demo programs in the "Demo Blocks" file, and the Going FORTH tutorial source code in the "Going FORTH" file. By logically organizing your source code into files you will find program development greatly simplified.

Practice Editing Block

In order to illustrate the use of the editor, we have provided a practice block for you to work with while completing this chapter. Begin by displaying the practice block with the editor. Execute

```
            5  EDIT
```

You should now see on your screen an edit window which looks like figure 3.1 below:



Blk# 5 of 23 ; File=Forth Blocks

```
( Sample Editing Practice Block )

CR ." Loading Editor Practice Block.."

: .PLUS  ( n1\n2 -- | add n1 to n2 and display the result )
   CR  OVER .  ." plus " DUP . +  ." equals "  .  ;

CR ." Editor Practice Block Loaded."
```

Figure 3.1

Editor Window

The MacFORTH editor uses its own window. The window is large enough to display one block of source code in a format 16 lines by 64 characters each for a total of 1024 characters (as you can see in Figure 3.1). The following list points out the features of the editor :

- **Title Bar**
  Displays the current block number being edited, the total number of blocks in the file and the file name. Each time you edit a different block this information is updated to show you exactly what you are editing.

- **Close Box**
  Lets you close the editor window by clicking in its close box. The editor window will reappear the next time you enter the editor.

- **Drag Region**
  Allows you to drag the edit window to a new position on the screen (remember to keep the entire window visible when editing).

- **Scroll Bar**
  The vertical bar on the right hand side of the window is the scroll bar. It allows you to scroll up and down within the current program file, selecting different blocks for editing.

  - Up Arrow
    Selects the previous block (numbered one less than the current block) as the block to edit. Stops on the first block in the file.

  - Down Arrow
    Selects the next block (numbered one more than the current block) as the block to edit. Stops on the last block in the file.

  - Scroll Box
    Drag the scroll box to select another block to edit. Move it up to edit lower numbered blocks and down to edit higher numbered ones.

  - Shaded Area
    Click inside the shaded area above or below the scroll box to move 3 blocks at a time in either direction (up or down).

Experimenting with the Editor

Let's try a few of the editor features:

<u>Close Box</u>
First, click inside the close box. The editor window disappears and the MacFORTH window becomes the active window. To make the editor window reappear, re-enter the editor by executing (from the MacFORTH window):

```
5  EDIT
```

<u>Scrolling</u>
With the edit window now the active window, here's how to move up in the file to block 4: click the up arrow in the scroll bar on the right side of the window. Click it once and it will move you up one block in the file ("up in the file" meaning to a lower numbered block). You'll see the title of the window change to

```
Blk# 4  of  23 ; File= FORTH Blocks
```

indicating that you are now displaying block number 4. Return to block 5 for editing by clicking the down arrow in the scroll bar once. You can see that you have returned to block 5 by the title of the editor window:

```
Blk# 5  of  23 ; File= FORTH Blocks
```

You can also move 3 blocks at a time in either direction in the file by clicking within the shaded area above or below the scroll box. Click in the shaded area below the scroll box once. You are now editing block 8 (you were previously on block 5).

Each time you edit a new block, the scroll box is moved up or down. Its position tells you what block you are editing relative to the start and end of the file.

By dragging the scroll box up or down within the shaded area, you can position the editor to edit any block in the file. Try dragging the scroll box to several different positions now. Simply drag it to a new location and release the mouse button to display the block being edited.

Moving the scroll box to the top position in the shaded area will position you to edit block 0 of the file. The bottom position in the shaded area positions you to edit the last block in the file. You can locate a particular block by positioning the scroll box in the approximate location from the beginning or end of the file. For example; since there are 24 (numbered 0 through 23) blocks in the "FORTH Blocks" file, if you wanted to edit block 12 you would position the scroll box approximately half way between the top and bottom of the scroll bar. Try to find block 12 now using the above technique.

Edit Menu

The Edit menu provides you with the following options while editing. Each item in the menu provides a powerful function at your fingertips (don't try these features just yet; simply read through the list to familiarize yourself with them):

Undo (⌘Z)
Undoes the previous cut, copy, or paste operation (including any changes since the last operation). It actually restores the contents of the block to the version since the last cut, copy or paste operation.

Cut (⌘X)
Cuts the current selection range (discussed later in this chapter) from the text and places it on the clipboard. (Cut, copy and paste use the clipboard just like other Macintosh applications).

Copy (⌘C)
Copies the current selection range (discussed later in this chapter) to the clipboard.

Paste (⌘V)
Inserts the contents of the clipboard to the block at the current cursor position and/or replaces the current selection range.

Stamp (⌘S)
Stamps the current block with the current date, as read from the internal clock, and initials stored in the user variable **INITIALS**. Use the word **@INIT** to change the value in **INITIALS**. **DATE** displays the current initials and date stamp. If the first three characters in **INITIALS** are non-printable ASCII characters or blanks, the stamp function is disabled.

Clean
Blank fills the contents of the block currently being edited. Use this command with caution as you **cannot** undo it.

Revert
Resets the contents of the current block back to the version saved on the disc. Use this command with caution as you **cannot** undo it.

Enter/Exit Editor (⌘E)
Allows you to enter or exit the editor.

Insertion Point

Any time the editor window is active, you will see a flashing vertical bar. This is called the ***insertion point***. Enter the editor to edit block 5 (use any of the methods described in the Entering the Editor section) and try typing the phrase (type it in only, do not press Return):

```
      This is the insertion point.
```

and you'll see it inserted at the insertion point. Everything to the right of the insertion point is shifted over each time a character is typed. Characters in the last position on the right are pushed right out of the window. Now delete what you just inserted by pressing the Backspace key once for each character you just entered (the key will repeat automatically if you hold it down).

You can change the insertion point by pointing with the mouse to the position where you want to insert text and clicking once. In the edit window, the cursor becomes an "I-beam" instead of an arrow to make it easier to select an insertion point between characters. Try moving the insertion point to several different places in the window now. Remember, position the i-beam cursor and click once. Each time you reposition it, the insertion point will be marked by the flashing vertical bar.

Try repositioning the insertion point to several places again, but this time, each time you position the cursor, type the phrase "abc" and backspace it away to get a feel for inserting and deleting text.

You can also insert a line at any point by positioning the insertion point and pressing the Return key. For example, position the insertion point between the words "Sample" and "Editing" in the first line in block 5 and press Return. Everything on the line to the right of the insertion point is shifted down to the beginning of the next line, all lines below it are shifted down one line. Press the Backspace key once to "glue" the lines back together. When you pressed the Return key, you inserted a carriage return. Pressing Backspace deleted it.

When you insert text in a line, all text to the right of it is shifted to the right. If you insert a Return, the text after the insertion point and all lines below are shifted down one line. You can recover the text that was pushed off the end of a line or the bottom of the screen by deleting some text (if off to the right) or deleting some lines (if off the bottom). To delete a blank line, just position the cursor against the left edge of the editor window and press Backspace.

While you <u>can</u> recover the text that has been pushed out of the window while you are editing, **only the visible text** is saved on the disc when you exit the editor. After any operation that saves the data in the disk buffers (stamp, clean, undo, etc. -- explained next) you **<u>cannot</u>** recover any text that you can't see.

The MacFORTH editor uses a simple, yet powerful "cut and paste" style of editing (similar to MacWrite). By now, you can see how to insert and delete text at the insertion points by typing in new text or backspacing it away.

<u>Selection Range</u>
If you are familiar with MacWrite this description will be a review. Cut, Copy and Paste operate on a range of selected information (ie: a text string). To select items for edit the I-beam cursor should be placed at the beginning of the desired text and dragged to the end of the "selection range".

For example, try entering the following line in the block (put it anywhere you like):

```
     Welcome to the world  of MacFORTH editing!!!
```

Now remove the word "MacFORTH" by selecting it and "cut"ting it out: click at the beginning of "MacFORTH", drag to the end of the word (it is now displayed in inverse characters) and release the mouse button when the entire word is selected (entirely in inverse characters). Select the "Cut" item from the "Edit" menu; the selection range is now deleted and saved on the clipboard. Bring it back by selecting "Paste" from the "Edit" menu.

You can now reposition the insertion point and paste the word "MacFORTH" anywhere in the current block. You can even move to a different block and paste it in that block! This should give you an idea of the power of the editor. You can cut or copy a selection from any block and paste it into any other block.

Loading Blocks

To load a block from disc, execute the **LOAD** command in the following form:

```
<block#>  LOAD
```

For example, to load the block you were editing, go back to the MacFORTH window and execute

```
5  LOAD
```

When a block is loaded, the source code on the screen is interpreted just as if you had typed it in from the keyboard. This enables you to mix definitions and commands to be executed immediately. When a block is loaded, the cursor automatically is changed to a wrist watch. After the block has finished loading it reverts back to the arrow cursor.

Error Detection While Loading a Block

If MacFORTH encounters an error while loading a block (an undefined word, a typo, missing delimiter, etc.), it will abort immediately and issue an error message. To find where the error occurred, simply enter the editor. The insertion point (flashing vertical bar) will be located just after the error. For example, if you have the sequence

```
QWERTY
```

in a block (and it was not a defined word) when you loaded the block, the insertion point would be one space after the "Y". This feature is invaluable for locating the cause of an error during loading because it shows you where MacFORTH encountered the error.

After an error has been detected, the variable **R#** is set to the position just after the error. The initial position of the insertion point is determined by the value in **R#**. If you want to have the insertion point at the upper left corner of the edit window, execute

```
R# OFF
```

from the MacFORTH window.

Listing Programs

The following words list your programs to the display and/or printer. If you have an Apple Imagewriter connected to your Mac, select the "Printer" item from the "Options" menu to turn it on. All output to the screen will be sent to the printer as well (refer to the Printer/Serial chapter for a discussion on using other printers).

LIST

Displays the specified block. The date, screen numbers, and lines of the block (numbered 0-15) are displayed. For example:

```
10 LIST
```

would list the contents of block 10.

INDEX

Displays the first line of a range of blocks. If you follow the convention of using the first line of each block as a comment describing the contents of the block, **INDEX** will allow you to see quickly what a range of blocks contains. For example:

```
5 15 INDEX
```

would display the first line of blocks 5-15, with the block numbers displayed on the left.

TRIAD

Displays three sequential blocks on one page, starting with a block that is evenly divisible by three. You specify the number of any block in the "triad" that you want to display. For example:

```
10  TRIAD
```

displays blocks 9, 10 and 11. This enables you to update your program listings with only the screens that have changed. The icon used for MacFORTH blocks (program) files contain three rectangles to designate triad listings.

SHOW

Displays a range of blocks (as a series of triads). Given the starting and ending blocks to display, **SHOW** generates a listing of triads. For example:

```
10  20  SHOW
```

would generate a listing of three blocks per page containing the specified range of blocks (it would actually list blocks 9-20).

Copying Blocks

The following routines allow you to copy the contents of one block (or blocks) to another (or others).

Single Block Copying

When copying limited numbers of blocks, use the **COPY** command in the following format:

```
      <source block#>  <destination block#>  COPY
```

For example, to copy the contents of block 6 to block 5, you would execute:

```
      6 5  COPY
```

Multiple Block Copying

If more than a couple of blocks need to be copied, a copying utility program is available. Load these routines by loading block 10 of the "FORTH Blocks" file. To copy a series of blocks from one location on the disc to another, use the **COPY.BLOCKS** in the following format:

```
      <first>  <last>  <target>  COPY.BLOCKS
```

For example, to copy blocks 3 thru 7 to screens 12 thru 16, execute (just an example, do not try this now):

```
      3 7 12  COPY.BLOCKS
```

During the copying procedure, you are shown which screens are being accessed with the following message:

```
      sss -> ddd
```

where sss is the source block number and ddd is the destination block being copied.

Copying Blocks from One File to Another

Load the block transfer routines by loading block 12 of the "FORTH Blocks" file. The word **XFER.BLOCKS** will allow you to copy blocks between files, promting you to enter the required information. You will be asked for the file numbers of both files as well as the range of blocks to be transferred.

Blank-Filling Blocks

To blank-fill a single block, select the "Clean" item from the "Edit" menu while editing the block. If you want to blank-fill a series of blocks, load the block copy routines (if you have already loaded them, you don't need to re-load them). You now have the word **CLEAR.BLOCKS**. It is used in the following format:

```
      <first>  <last>  CLEAR.BLOCKS
```

For example, to blank-fill blocks 20 thru 25 in the current blocks file, you would execute (don't try this example):

```
      20 25 CLEAR.BLOCKS
```

Each time a block is cleared, the message

```
      ccc Cleared
```

is displayed, where ccc is the number of the block being cleared.

Cutting and Pasting to/from the Desk Accessories

You can cut, copy and paste selected text to/from the Desk Accessories. This allows you to share ASCII data between MacFORTH and any other Macintosh system.

To move ASCII data from MacFORTH to the Notepad for example, enter the editor and cut (or copy) the desired text. Select the Notepad item from the apple menu and paste the selected text into the Notepad.

To move ASCII data from the Notepad to MacFORTH, select the Notepad item from the apple menu and cut (or copy) the desired text. Enter the editor in MacFORTH and paste the selected text into a block.

A Final Note

If you have modified block 5 (the example block) you should go back now and edit it so it looks like figure 3.1. This makes it easier if you need to go back and try the examples again later.

Chapter 4: Getting Started

Overview

This chapter will give you first-hand experience in programming the Macintosh. You will enter a sample program, try it out, make some changes, and try it again to see the differences. Don't try to understand each command now. The intent of this chapter is to give you a feel for programming the Macintosh, **not** to give a comprehensive description of each command. Later chapters will fill in the missing information. For now, just enter the example program and enjoy.

By the time you finish this chapter, you will have created a new window, defined a program to be executed for the window, tracked the mouse, created some graphics pictures (and printed them if you have an Apple Imagewriter printer), and defined a menu.

Preparations

By now you should have completed the Going FORTH tutorial, if you haven't, do so **now** before you continue. You will be instructed to edit some source code into the "FORTH Blocks" file. If you skipped the Program Editing chapter, read it **now** before you continue.

It is important that you complete this chapter in one sitting.

The only thing you'll need is about 20 minutes of time, your Mac, MacFORTH, and you.

Restart your computer (by turning the power off then on) and load MacFORTH by opening the "FORTH Blocks" document from the Finder (by double clicking it). When MacFORTH loads, enter your initials when asked and you'll get "ok". You are now ready to start.

Finger Paint Example Program

The example program you will be entering will allow you to create pictures in a new window using the mouse. Press the Return key a few times to see where your cursor is (some more "ok"s will appear).

Prior to typing in the following example, resize the MacFORTH window and drag it down to the lower one-third of your screen, keeping the whole window on the screen (your screen should be similar to figure 4.2, except the Finger Paint window won't be present yet). This will expose the editor window. During the course of the following example another window (the Finger Paint window) will be defined and will appear in the upper left corner of the screen.

One other reminder before you start typing; **spaces** separate words in FORTH, so pay careful attention to spacing in this example (particularly after quotation marks).

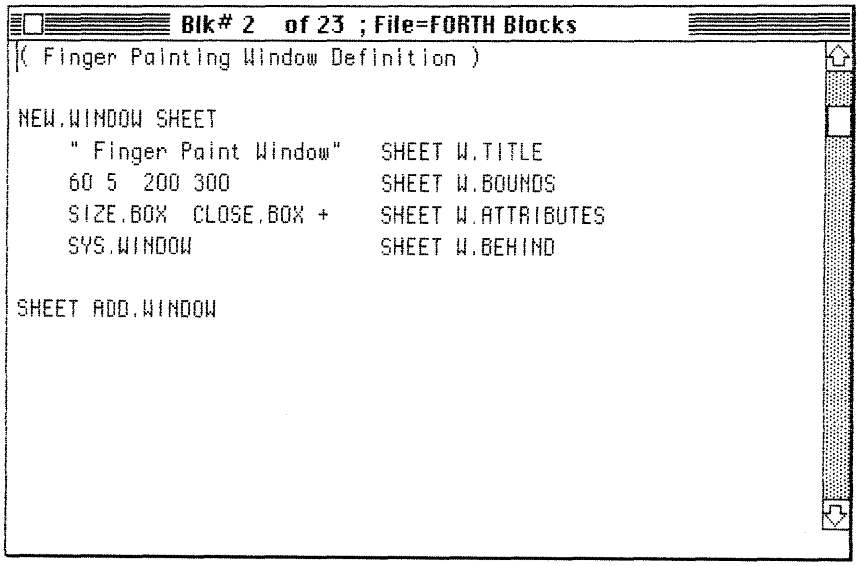
You will use blocks 2 thru 4 of the "FORTH Blocks" file to enter the source code for this example. If there is already source code in any of the blocks, clean the block by selecting the "Clean" item from the "Edit" menu (be sure that you are editing the correct block before you clean it).

Finally, remember to put the comment (in parentheses) in the topmost line of the block.

Create a Window
Edit the following source code into block 2:

```
( Finger Painting Window Definition )

NEW.WINDOW  SHEET
   " Finger Paint Window"  SHEET  W.TITLE
   60 5  200 300           SHEET  W.BOUNDS
   SIZE.BOX  CLOSE.BOX +   SHEET  W.ATTRIBUTES
   SYS.WINDOW              SHEET  W.BEHIND

SHEET  ADD.WINDOW
```

Your block should now look like the block in figure 4.1. If there are differences use the editor to correct them before you continue:



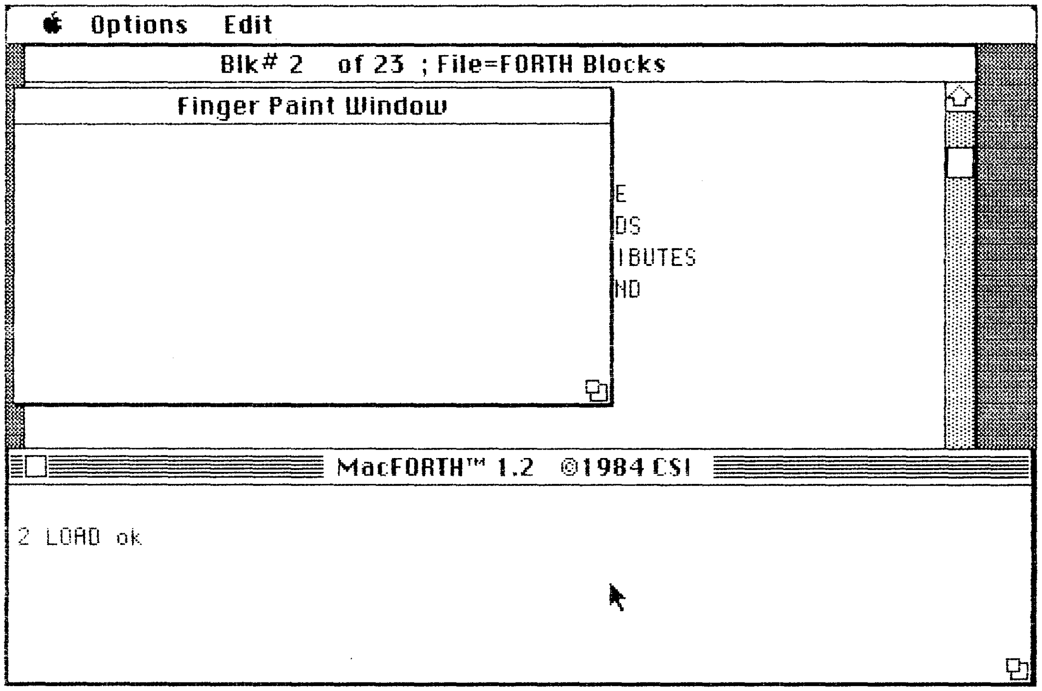
```
( Finger Painting Window Definition )

NEW.WINDOW SHEET
     " Finger Paint Window"   SHEET W.TITLE
     60 5  200 300            SHEET W.BOUNDS
     SIZE.BOX  CLOSE.BOX +    SHEET W.ATTRIBUTES
     SYS.WINDOW               SHEET W.BEHIND

SHEET ADD.WINDOW
```

Figure 4.1

Now load the block by executing:

```
2 LOAD
```

At this point a new window will appear in the upper left corner of the screen. Your screen should now look just like figure 4.2.



```
2 LOAD ok
```

Figure 4.2

If you click in the new window the system will just beep at you. Click back inside the MacFORTH window and continue.

Track the Mouse

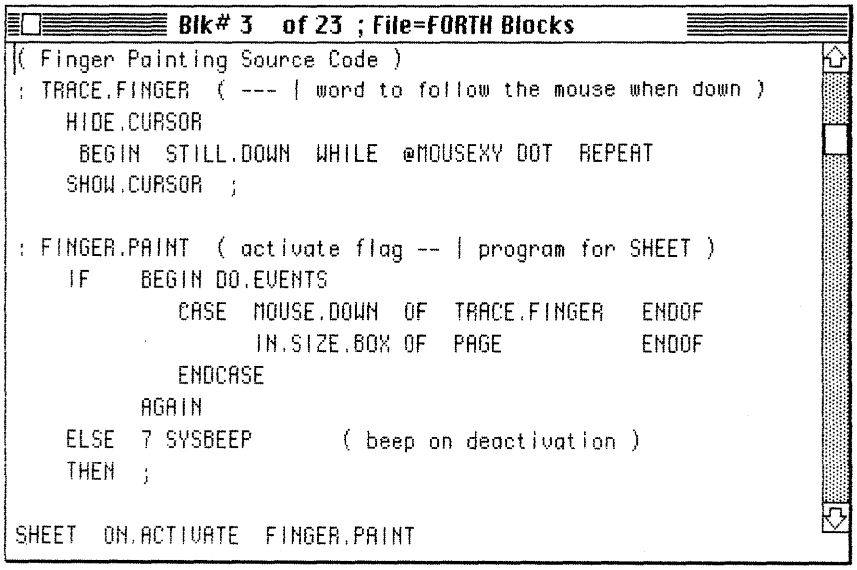
Edit the following source code into the top of block 3:

```
( Finger Painting Source Code )
:  TRACE.FINGER  ( --- | word to follow the mouse when down )
     HIDE.CURSOR
      BEGIN  STILL.DOWN  WHILE  @MOUSEXY DOT  REPEAT
     SHOW.CURSOR   ;
```

Define the Window Program
Edit the following source code into the bottom of block 3 (under the source code for **TRACE.FINGER**):

```
: FINGER.PAINT   ( activate flag -- | program for SHEET )
    IF    BEGIN  DO.EVENTS
            CASE  MOUSE.DOWN  OF TRACE.FINGER ENDOF
                  IN.SIZE.BOX OF PAGE         ENDOF
            ENDCASE
          AGAIN
   ELSE   7 SYSBEEP         ( beep on deactivation )
   THEN  ;

SHEET  ON.ACTIVATE  FINGER.PAINT
```

Your block should now look like the block in figure 4.3. If there are differences, use the editor to correct them before you continue.


Blk# 3   of 23 ; File=FORTH Blocks

```
( Finger Painting Source Code )
: TRACE.FINGER  ( --- | word to follow the mouse when down )
   HIDE.CURSOR
    BEGIN  STILL.DOWN  WHILE  @MOUSEXY DOT  REPEAT
   SHOW.CURSOR  ;

: FINGER.PAINT  ( activate flag -- | program for SHEET )
   IF    BEGIN DO.EVENTS
            CASE  MOUSE.DOWN  OF  TRACE.FINGER   ENDOF
                  IN.SIZE.BOX OF  PAGE           ENDOF
            ENDCASE
         AGAIN
   ELSE  7 SYSBEEP       ( beep on deactivation )
   THEN  ;

SHEET  ON.ACTIVATE  FINGER.PAINT
```

Figure 4.3

Load the block by executing:

```
3 LOAD
```

Finger Painting

Activate the finger paint window by pointing to it with the mouse and clicking down inside it. When you drag the mouse around in that window, the cursor disappears and a line follows where you move the mouse. You can even drag outside the window and come back in. When you release the mouse button (ie. stop dragging), the cursor re-appears and you don't get a line following you anymore.

Try moving the cursor and clicking in the MacFORTH window now. The Mac beeps at you when you de-activate the **SHEET** window (its title is "Finger Paint Window") as you told it to do in **FINGER.PAINT**. Now resize the **SHEET** window so your drawing space is larger (but leave both windows visible).

When you resize the **SHEET** window, the picture you drew is erased and you are given a clear space to work in.

Hide the sheet window (by clicking in its close box at the top left corner). To make it re-appear, execute (from the MacFORTH window):

```
        SHEET  SHOW.WINDOW
```

You can now activate the **SHEET** window (by clicking in it) and do some more drawing.

Re-Title the Window

Go back to the MacFORTH window (by clicking in it). Now change the title of the new window to your name. For example, if your name is Marge, execute:

```
        " Marge's Artwork" SHEET SET.WTITLE
```

or Harry:

```
        " Harry's Impressions" SHEET SET.WTITLE
```

or, if you prefer:

```
        " My Very Own Easel" SHEET SET.WTITLE
```

Printing the Picture

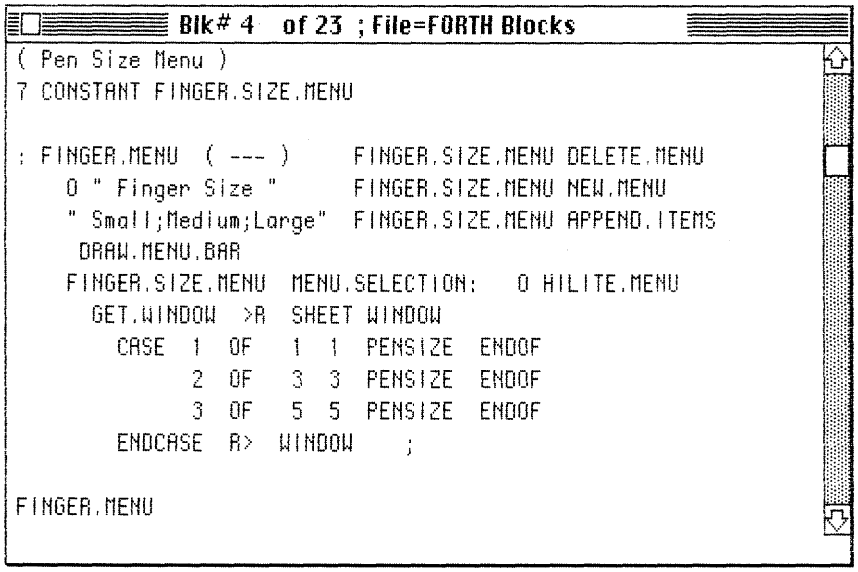
You can even print your work of art if you have an Apple Imagewriter printer. If you have one connected to your Mac, execute **⌘$** (hold down the **⌘**, shift, and 4 keys simultaneously) If the Caps Lock key is up, only your sheet is printed, if the Caps Lock key is down, the entire screen is printed.

Define the Pen Size Menu

As the final addition to the program, create a menu to change the size of the pen you are drawing with. Edit the following code into block 4:

```
( Pen Size Menu )
7  CONSTANT  FINGER.SIZE.MENU

:  FINGER.MENU  ( --- )    FINGER.SIZE.MENU  DELETE.MENU
     0 " Finger Size "     FINGER.SIZE.MENU  NEW.MENU
     " Small;Medium;Large" FINGER.SIZE.MENU  APPEND.ITEMS
     DRAW.MENU.BAR
    FINGER.SIZE.MENU MENU.SELECTION:  0 HILITE.MENU
        GET.WINDOW >R  SHEET  WINDOW
           CASE  1  OF  1  1  PENSIZE  ENDOF
                 2  OF  3  3  PENSIZE  ENDOF
                 3  OF  5  5  PENSIZE  ENDOF
           ENDCASE  R>  WINDOW    ;
FINGER.MENU
```

Your block should now look like the block in figure 4.4. If there are any differences, go back into the editor now and correct them before you continue.



Blk# 4 of 23 ; File=FORTH Blocks

```
( Pen Size Menu )
7 CONSTANT FINGER.SIZE.MENU

: FINGER.MENU  ( --- )     FINGER.SIZE.MENU DELETE.MENU
    0 " Finger Size "      FINGER.SIZE.MENU NEW.MENU
    " Small;Medium;Large"  FINGER.SIZE.MENU APPEND.ITEMS
     DRAW.MENU.BAR
    FINGER.SIZE.MENU  MENU.SELECTION:   0 HILITE.MENU
      GET.WINDOW  >R  SHEET WINDOW
        CASE  1  OF   1  1  PENSIZE  ENDOF
              2  OF   3  3  PENSIZE  ENDOF
              3  OF   5  5  PENSIZE  ENDOF
        ENDCASE  R>  WINDOW    ;

FINGER.MENU
```

Figure 4.4

Now load the block by executing:

```
        4  LOAD
```

Now you will see the "Finger Size" menu on your menu bar line. Pull it down and select a new finger size. Activate the **SHEET** window and draw a few lines. Return to the "Finger Size" menu and select a new finger size. Draw a few more lines and re-select a new finger size.

When you get tired of the current pattern, re-size the window and start all over if you like.

Summary

You've seen how simple it is to create a new window, assign a program to the window, track the mouse, create graphics pictures (and possibly print the result), and create a new menu.

That's it! As we said at the beginning, our intent in this chapter was simply to introduce you to some of the features of the Macintosh, **not** to give a detailed description of each function.

Chapter 5: Getting Results

Overview

There are some basic features of the Macintosh you need to understand before you can use it effectively. To illustrate these features, we will present a series of examples, similar to the method used in Getting Started, but giving a more detailed explanation of the commands as they are presented.

Many of the commands you will use in this chapter will be easy to understand at first glance. The example in which the command was introduced should make its usage clear. Others will require more explanation. We will explain the topic being presented and give any additional information you need to know to understand the example. If you want to know more about a particular command, refer to either the appropriate reference chapter of this manual or the glossary.

As you go through this chapter, be sure that you try each example **before** you go on to the next, as we will use each step to build the next (very much like a FORTH program).

Some of the examples are short enough that you can execute them directly from the keyboard without saving them (you will be instructed to "execute" the example). Others are longer and you may be asked to modify them later. To avoid re-typing the entire example, you will be instructed to save the example in a block on disc (using the editor -- you will be instructed to "edit" the example, then "load" it). If you skipped over the Editor chapter, stop **now** and read it. We will assume that you know how to use the editor to complete this chapter.

When MacFORTH words are included within text, they are printed in bold face capital letters to differentiate them from the rest of the text. We use the convention of capitalizing all MacFORTH words. This is by no means mandatory, as MacFORTH does not discriminate between upper and lower case FORTH words (**WORDS** is equivalent to **words** or **Words**, or even **WoRdS**) when executing the name of a definition. If this is important to you, refer to the Advanced Topics chapter discussion of the **LOWER.CASE** option.

Set Up a Work File

We begin this section by creating a blocks file for you to use. If you or someone else has already gone through this chapter, the file may already exist.

<u>Displaying the Disk Directory</u>
Look at the contents of the disc by executing

```
      INTERNAL  DIR
```

This will display the directory of the disc in the internal drive.

<u>If the File Exists</u>
If the file "Work File Blocks" already exists (it is in the directory listing), someone else has created it, execute

```
      USE" Work File Blocks"
```

You can now edit the "Work File Blocks" file.

<u>If the File Doesn't Exist</u>
If the file "Work File Blocks" doesn't exist (it doesn't appear in the directory listing), you need to create it. Execute the following (don't forget a space after the quotation marks):

```
      12  " Work File Blocks"  NEW.BLOCKS.FILE  CONSTANT WORK.FILE
```

This will give you a working file named "Work File Blocks" with 12 blank blocks to use as you complete this chapter. (You may want to keep it around as you go through the manual in order to keep any examples you might want to reload.)

<u>File Commands Used</u>
NEW.BLOCKS.FILE creates a new blocks file with the specified name and number of blocks. If successful, it returns the file number of the new file. If an error occurs while creating the new file, an error message is displayed, and processing is aborted.

The constant **WORK.FILE** is used as a convenient reference to the newly created file. You should use a constant when referring to a file for the sake of readability.

Windows

One of the most innovative features of the Mac is its ability to create and display windows. Each window can be used for a different purpose and can run its own program. Let's begin this example by resizing the MacFORTH window to about two inches high at the bottom of the screen.

Drag the size box upwards to shrink the window to about two inches high. Next drag the entire MacFORTH window down to the bottom of the screen. Your screen should now look like figure 5.1 below.

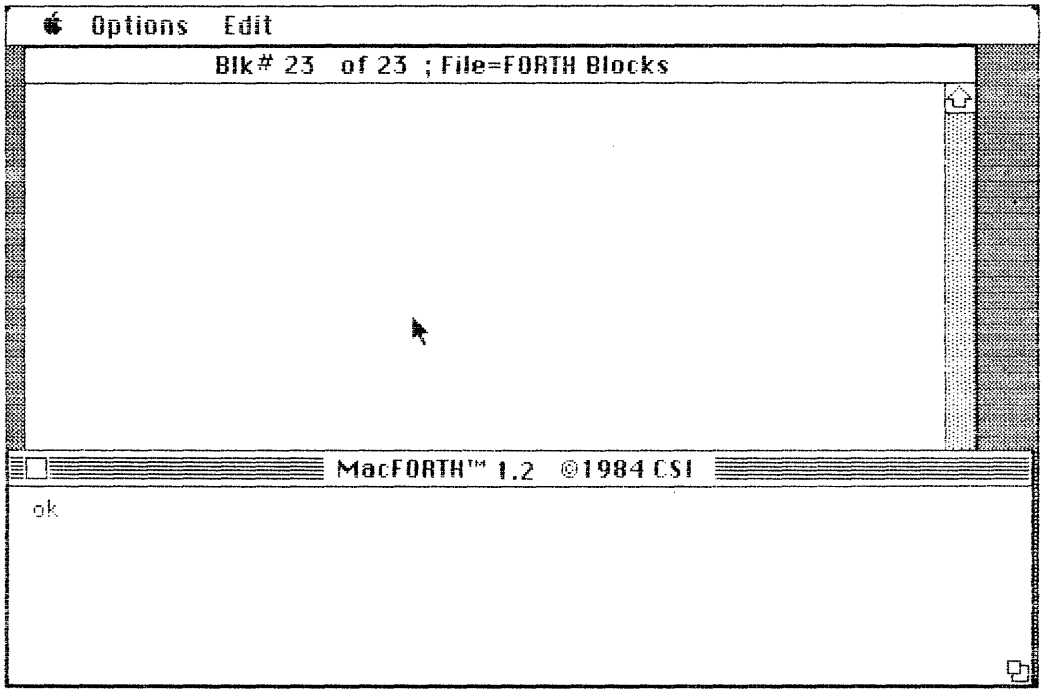


Figure 5.1

Next create a new window named **TEST.WINDOW** and add it to the display. Execute the following:

```
      NEW.WINDOW   TEST.WINDOW
      TEST.WINDOW  ADD.WINDOW
```

At this point the new window will appear and become the active window. Click in the MacFORTH window and continue.

NEW.WINDOW created a window definition named **TEST.WINDOW**. Each window created in MacFORTH has an array associated with it which contains information about the window. Information about the size, starting location, program to execute, text font, size, mode and style, etc. that pertains to the window is stored in this array. The address of this array (the "window pointer") is left on the stack when you execute the name of the window. When you want to reference your new window, use the MacFORTH word **TEST.WINDOW** which you just created. **TEST.WINDOW** will place the "window pointer" (or "wptr" in stack notation) for this window on the stack. The MacFORTH routines which manipulate windows require the window pointer for the window to be on the stack.

All windows that can be displayed are kept in a list of windows maintained by the Macintosh. **ADD.WINDOW** inserts the window specified (by its window pointer) into the Mac's list of windows, displays it, and makes it the active window.

Only one window can be active at a time. All input/output is by default sent to the active window. To activate a new window, simply click the mouse down in the window that you want to become active. Click down in the new window and then back in the MacFORTH window.

The default action of any window when it is activated is to beep for all user events (mouse down, keystrokes, etc.). The **ON.ACTIVATE** command allows you to specify the program to execute when the window is activated. Execute:

```
      TEST.WINDOW ON.ACTIVATE QUIT
```

to specify the program **QUIT** to execute when **TEST.WINDOW** is activated. **QUIT** is the program which runs MacFORTH itself (it waits for input, executes it, and responds "ok"). Now try clicking in **TEST.WINDOW** and pressing Return. Go back to the MacFORTH window (by clicking in it) and continue.

You can also activate another window by using the **SELECT.WINDOW** command. **SELECT.WINDOW** expects the window pointer of the window to be selected on the stack. For example, to activate the new window from the MacFORTH window, execute:

```
      TEST.WINDOW SELECT.WINDOW
```

and go back to the MacFORTH window by clicking in it.

Try dragging each window around on the screen (if you don't know how to do this, run the Guided Tour provided with your Macintosh). Place them in any position you like, but be sure each window is visible when you are done.

Error Handling

When an error occurs in a window other than the MacFORTH window, the MacFORTH window is activated. The error message (if any) is displayed in the MacFORTH window, <u>not</u> the window the error occurred in.

This enables you to do any debugging from the MacFORTH window, allowing you to see when and how the error occurred. For example, activate **TEST.WINDOW** and execute:

```
      QWERTY
```

and you will see the error message

```
      QWERTY ?
```

appear in the MacFORTH window because MacFORTH doesn't understand the word **QWERTY**.

Forgetting a Window

When you forget a window, it is removed from the Macintosh window list and taken off of the display (if visible). Forget your new window now by executing:

```
      FORGET TEST.WINDOW
```

Any references to **TEST.WINDOW**, as with any other forgotten FORTH word, will not be understood by MacFORTH as it has been removed from the dictionary.

Window Attributes

You can see that the MacFORTH window has both a size box and a close box; the editor window has only a close box, and the new window has neither. These are all attributes about a window that can be included or left off, depending on what you want the window to do.

Let's continue by creating a new window to work with. Edit the following example into block 2 of your "Work File Blocks" file:

```
    (  New Window Example  )
    NEW.WINDOW  EX.WINDOW
      " Example Window"      EX.WINDOW  W.TITLE
       CLOSE.BOX SIZE.BOX +  EX.WINDOW W.ATTRIBUTES

    EX.WINDOW  ADD.WINDOW
```

Now load it by executing

```
    2 LOAD
```

EX.WINDOW has two new features that the previous window you created didn't have: a close box and a size box. The word **W.ATTRIBUTES** allows you to define the features of a window when it is created. These features were given to the window when you executed:

```
            CLOSE.BOX SIZE.BOX + EX.WINDOW  W.ATTRIBUTES
```

Refer to the Window chapter for a complete listing of all possible window attributes.

The default title for a window is "Untitled" (as you saw in the first window you created). **W.TITLE** allows you to assign your own title to a window. **W.TITLE** expects a string address on the stack (the string address was left on the stack by the word ") under the window pointer. By executing

```
    " Example Window" EX.WINDOW W.TITLE
```

in the above example, you assigned the title "Example Window" to the window **EX.WINDOW** (we refer to windows by their FORTH name for clarity.)

Changing the Window Title

You can also change the window title after it has been displayed using the word **SET.WTITLE**. For example, execute the following to change the name of the new window to "Example Workspace":

```
" Example Workspace" EX.WINDOW SET.WTITLE
```

Activate the editor window now (by either clicking in it or choosing the "Enter Edit" item from the "Edit" menu). Its title is:

Blk# 2 of 11; File = WORK FILE BLOCKS

Now edit block 1 by clicking the up arrow of the editor control bar. The title of the menu changes to:

Blk# 1 of 11; File = WORK FILE BLOCKS

The MacFORTH editor uses the **SET.WTITLE** command to change the title of the editor window each time a different block is displayed.

Closing a Window

When you close a window by clicking in its close box, it is hidden from view. The window closest to the "front" of the display (the "top" window is then activated. Select **EX.WINDOW** by executing

```
EX.WINDOW SELECT.WINDOW
```

Now click in its close box. When **EX.WINDOW** disappeared, the "top" window became active. Be sure the MacFORTH window is active now by clicking in it.

Hiding and Showing a Window

From the above example, you saw how you can hide a window by clicking in its close box. To make a window re-appear, use the **SHOW.WINDOW** command. **SHOW.WINDOW** re-displays the window specified by the window pointer given. Execute the following to make **EX.WINDOW** re-appear:

```
EX.WINDOW  SHOW.WINDOW
```

EX.WINDOW is now there, but it is <u>behind</u> the active window, in this case, the MacFORTH window. To see **EX.WINDOW**, close the editor window (enter the editor and click in its close box), then close the MacFORTH window by clicking in its close box. There it is!! Remember, **SHOW.WINDOW** makes the specified window visible, but not <u>active</u>. A "visible" window is on the desktop, but may be currently <u>under</u> another window.

You can also hide a window with the **HIDE.WINDOW** command. Like **SHOW.WINDOW**, **HIDE.WINDOW** expects a window pointer on the stack. Return to the MacFORTH window by selecting the "MacFORTH Window" item from the "Options" menu. Execute the following to make the MacFORTH window disappear:

```
SYS.WINDOW  HIDE.WINDOW
```

Return to the MacFORTH window by selecting the "MacFORTH Window" item from the "Options" menu.

Window Bounds

You can also set the initial position and size of a window using the **W.BOUNDS** command. Edit the following example into block 3:

```
( New Window  TEST.WINDOW2  Example  )

NEW.WINDOW  TEST.WINDOW2
  " Test Window 2" TEST.WINDOW2 W.TITLE
  100 150 300 400  TEST.WINDOW2 W.BOUNDS

TEST.WINDOW2  ADD.WINDOW
```

Now load it by executing

```
3  LOAD
```

You created a new window named **TEST.WINDOW2**, gave it the title "Test Window 2", set its starting position to 100,150 relative to the top left corner of the screen (which is at 0,0) and made it a window 200 dots (300-100=200) by 250 dots (400-150=250).

The values 100 150 300 400 defined the window size by giving its "tlbr" (top, left, bottom, right) values. This is easy to remember, because windows have four sides: top, left, bottom, and right. So in the example, the top of the window is100 dots from the top of the screen, the left side of the window is 150 dots from the left side of the screen, the bottom of the window is 300 dots from the top of the screen, the right side of the window is 400 dots from the left side of the screen.

The default window bounds are

```
100 100 200 300 W.BOUNDS
```

Modifying the Cursor

You can change the type of cursor (currently an arrow) using the **SET.CURSOR** command. For example, to change the cursor to the wristwatch cursor (the cursor displayed when the Mac wants you to wait), execute:

```
            WATCH SET.CURSOR
```

Return to the arrow cursor by executing:

```
            INIT.CURSOR
```

The optional cursors you can select with **SET.CURSOR** are:

IBEAM	(the cursor used in the editor)
WATCH	(the wristwatch)

You can also fetch the current cursor with **GET.CURSOR**. This is useful for the times you want to change the cursor during a specific operation and then restore it to its previous image. The following example changes the cursor to a wristwatch during a delay loop, then restores the cursor to its previous image (enter it into block # 4):

```
            :  DELAY   ( --- )
                 GET.CURSOR  (  save  the  current  cursor  on  the
                                stack )
                 WATCH  SET.CURSOR
                 10000 0 DO  LOOP ( a delay loop that does nothing )
                 SET.CURSOR  ;   ( restore the cursor )
```

Load it by executing

```
            4 LOAD
```

and try a few tests:

```
            INIT.CURSOR  DELAY
            IBEAM SET.CURSOR  DELAY
```

Remember, if you try

```
            WATCH SET.CURSOR  DELAY
```

you won't know when the test is complete until you get "ok".

Execute

```
            INIT.CURSOR
```

to return the cursor to the arrow before you continue.

Refer to the "More Examples" file for more examples of cursors.

Hiding the Cursor

You can hide the cursor (make it invisible) by executing the **HIDE.CURSOR** command. To make it reappear, execute the **SHOW.CURSOR** command. These commands are useful when you don't want the cursor to interfere with the process being performed. We used them in the Getting Started chapter finger painting example.

Use them with one important caution in mind, however. The user expects to see the cursor move when she or he moves the mouse. If the cursor is hidden, it will appear that the system is not responding. If you hide the cursor, be sure to make it reappear when you are done.

Directing Output to a Window

There are times you want to get information or change some characteristic of a window without activating it. The commands **WINDOW** and **GET.WINDOW** allow you to access the information about a window without activating the window. **WINDOW** selects a specified window for output, and **GET.WINDOW** returns the window pointer of the current window.

For example, the window **EX.WINDOW** was created with the default text font and mode (these characteristics are discussed in detail in the Graphic Results chapter). The MacFORTH window uses text font 4, and text mode 2. To set the **EX.WINDOW** text font and text mode to be the same as the MacFORTH window, edit the following definition into block five:

```
: CHANGE.TEST  ( --- )
  GET.WINDOW ( save current wptr on the stack)
   EX.WINDOW  WINDOW   ( select EX.WINDOW )
     CR ." Before..."
     4  TEXTFONT      ( select the text font )
     2  TEXTMODE      ( select the text mode )
     CR ." After"
  WINDOW   ;   ( restore the window )

CHANGE.TEST
```

Load and test it via

```
5 LOAD
```

When **WINDOW** is executed, it makes the selected window the current window for output. If you execute **WINDOW** outside of a definition (via the keyboard), be sure to re-select the MacFORTH window before you press return (the name of the MacFORTH window is **SYS.WINDOW**). If you don't re-select the MacFORTH window, all output is directed to the other window until you execute

```
          SYS.WINDOW WINDOW
```

You can see that the word "Before" was displayed in the default Macintosh font. "After" was displayed in the MacFORTH default textfont.

The Mouse

You can read the current position of the mouse at any time with the word **@MOUSEXY**. The x and y coordinates of the mouse are returned on the stack (x under y). Here's a word to follow the mouse and report its current position *relative to the active window*:

```
          :  TRACK.MOUSE  ( --- )
               BEGIN CR ."  Mouse At: " @MOUSEXY SWAP . .  AGAIN ;

          TRACK.MOUSE
```

This will send you into an infinite loop which prints the current position of the mouse. Try it out. Move the mouse all over the screen and you'll see the position change.

To get out of this word (or to escape from any endless loop that displays output), select the "Abort" item from the "Options" menu (or press ⌘A).

Text Output

So far, we have used ." exclusively as the way to output character data. You can also type a string from memory or emit a single character. The word **EMIT** displays the ASCII character given on the stack (refer to the ASCII Chart on the last page of the manual for specific ASCII characters). For example, to output an asterisk, execute (in decimal):

```
          42 EMIT
```

To type a string from memory, use the words **COUNT** and **TYPE**. MacFORTH strings contain the length of the string in the first character position, followed by the string itself. Given the address of a string, **COUNT** returns the address of the first character in the string under the length of the string (in bytes). **TYPE** displays a string given an address and length on the stack.

Creating a String
There are many ways to create strings in MacFORTH. Here are the two most common methods:

a.) The word " creates a string in the object area (delimited by ") and leaves its address on the stack. You have already used this technique when defining window and file names earlier in this chapter. The format for this method is:

```
        " <string>"
```

Remember, the leading quote is a MacFORTH word, it must have a space before and after it. The space after it is not included in the string, it separates the string from the forth word " . The delimiting quote does not need a space before or after it (we recommend you leave a space after it for readability). For example, to create and display a string containing the name of the first NASA Space Shuttle, you would execute:

```
        " Columbia" COUNT TYPE
```

Note: The string address is left on the stack and cannot be re-calculated. If you need to use the address more than once, duplicate the address before using it.

b.) You can create a named string using **CREATE** and ," in the following format:

```
        CREATE <string name>  ," <string>"
```

Like " , you must have a space immediately following ," . The advantage to this method is that you can refer to the string by name. For example, to create a string containing the name of the second NASA Space Shuttle, execute:

```
        CREATE  SHUTTLE$  ," Challenger"
```

To display the name, execute:

```
        SHUTTLE$ COUNT TYPE
```

Keyboard Input

MacFORTH allows you to control input from the keyboard from the level of a single keystroke at a time to input of numbers and strings.

Input of Keystrokes
The word **KEY** captures ASCII keys from the keyboard (command keys are executed automatically) and returns the character value on the stack (refer to the ASCII chart appendix for the ASCII character values). For example, execute:

```
            KEY .
```

and press the "*" key (shifted 8), and you'll see that the ASCII character value for asterisk is 42. When **KEY** executes, it does not display the keystroke (as you saw, the * was not displayed). If you want the keystroke displayed, duplicate the value (with **DUP**) and **EMIT** it. This word is handy for words like:

```
   : ANSWER.Y/N  ( -- flag | flag = -1 if Y, 0 if anything  else )
        ." Answer Yes or No (Y/N) ->"  KEY DUP EMIT  89 ( Y ) =  ;
```

Now try executing ANSWER.Y/N and responding with uppercase Y or N. The flag returned on the stack is true if a capital Y was pressed. Now try it out. Execute

```
            ANSWER.Y/N  .
```

and press uppercase Y. Now try the same test, but this time press a different key.

If you wanted to look for either an upper or lowercase Y (uppercase Y has ASCII value 89, lowercase y has ASCII value 121), you could modify **ANSWER.Y/N** and replace the phrase

```
            89 ( Y ) =
```

with:

```
            DUP 89 ( Y ) =  SWAP 121 ( y ) =  OR
```

Note: **KEY** traps the following keys:

Return	(converts it to 0)
Backspace	(ignores it and beeps)
Tab	(converts it to an ASCII space)

Refer to the "Handling Keystrokes" section of the Windows chapter for more information.

Number Input

To input a number using MacFORTH, use **INPUT.NUMBER**. **INPUT.NUMBER** accepts a number of up to the width specified (in digits). After you press Return, the number is converted from a string to binary. If the string is a valid number, the number is returned on the stack under a true flag. If the string is not a valid number, a zero is returned under a true flag. If no number is input (the operator just pressed Return) a false flag is returned. Try:

```
5 INPUT.NUMBER CR . .
```

After you press Return, MacFORTH will be waiting for input. Input the number 123, then press Return. The numbers on the top of the stack are -1 and 123. This indicates a number was input, and the number is 123. Now try another example. Execute:

```
5 INPUT.NUMBER CR . .
```

Again, after you press Return, MacFORTH will be waiting for input. This time, input an invalid number. Input

```
DUD
```

Since "DUD" is not a valid number, a 0 was returned on the stack under a -1, indicating a string had been input, but it was invalid.

During conversion of the string to binary, if an invalid numeric character (not 0 thru 9 or minus sign) is encountered, MacFORTH will stop converting the string to a number. The number converted up to that point will be returned on the stack under a true flag. If the first character is invalid, a zero is returned under a true flag.

If nothing is input (the operator just presses Return), a zero flag is returned.

If this seems like a lot of things to remember for just inputting a number, you could define a word like:

```
:  ASK.NUMBER  ( -- n )
BEGIN CR ." Input Number ->" 3 INPUT.NUMBER UNTIL ;
```

When **ASK.NUMBER** is executed, it will repeat the prompt "Input Number ->" until a number is entered, and leave the converted number on the stack.

String Input

The word **INPUT.STRING** accepts a string of characters from the keyboard. It takes an address to store the string under the maximum number of characters to input (up to 255). This way you can control how many characters can be input. When **INPUT.STRING** is executed, the system will stop what it is doing and wait for a string to be input. The following example will input a string of up to 12 characters to **PAD** (the MacFORTH scratchpad buffer), and then display it. Remember, once you execute **INPUT.STRING** (by entering the following phrase), the system will wait for a string to be input. Now try:

```
            PAD 12 INPUT.STRING
```

After you press Return, MacFORTH will wait for you to input a string. Input the string (up to 12 characters) and press Return. To see the string you input, execute:

```
            PAD COUNT TYPE
```

You can also use **INPUT.STRING** to input into a string variable. The following example will create a string variable named **NAME$** and input a string into it:

```
            CREATE NAME$ ," Bill Smith"
            NAME$ COUNT TYPE
```

After you enter the next line, the system will wait for you to enter the name string, so input the name Joan Jones.

```
            NAME$  10  INPUT.STRING
            NAME$  COUNT TYPE
```

Warning: If you try to enter a string longer than the original string into a string variable, you will overwrite part of the object area and may cause the system to crash. Be sure that the string variable you are using is long enough by counting the number of characters in it. An easy way to create a string variable of the proper length is to use numbers in the string. For example, to create a string variable 18 characters long, you could execute:

```
            CREATE MY$ ," 123456789012345678"  ( 18 char string )
```

If you aren't sure of the current length of a string, just fetch the count. For example, to fetch the length of MY$ you would execute

```
            MY$  C@
```

Window Function

The default program for a newly created window when it is activated is to just beep at all mouse clicks or keystrokes. You can assign a program to a window using the **ON.ACTIVATE** command. When the window is activated, the program assigned to it is executed.

When a window is activated, its program is passed a flag telling whether it is being activated (a true flag) or deactivated (a false flag). The program then determines what to do and runs.

When a window is deactivated (by activation of another window, or by closing the window), the program it is running is aborted immediately, and the activated window is given control to run its program.

To illustrate this point, activate the MacFORTH window and execute the following:

```
: TEST   ( --- )
    100 0  DO  I .  LOOP   CR  ." Test Done"  ;

TEST
```

As you would expect, **TEST** displayed the numbers 0 through 99, output a carriage return and displayed "Test Done".

Execute **TEST** again, but this time, <u>before</u> it completes, activate **EX.WINDOW** (by clicking in it). As soon as you activated **EX.WINDOW**, did you see that **TEST** stopped executing and control was passed to **EX.WINDOW**? Re-activate the MacFORTH window and you'll get "ok", indicating **TEST** was aborted, and MacFORTH is waiting for your next request.

Assigning a Program to a Window

You assign a program to a window using the **ON.ACTIVATE** command. This program will replace the default program. Any program assigned to a window will be passed a flag when the window is activated telling it whether the window was activated (a true flag) or deactivated (a false flag). This allows you to do any initialization when the window is activated, and perform any clean up when the window is deactivated. Your program must be aware of this flag and handle any special cases for activation or deactivation.

To illustrate this feature, assign a program to **EX.WINDOW** and watch it run. Edit the following example into block #6 (and then load it):

```
: TEST.ACTIVATE   (  flag -- )
    IF   ." Window Activated!!"    3 SYSBEEP   WORDS
    ELSE ." Window Deactivated!!"  3 SYSBEEP
    THEN  ;

EX.WINDOW  ON.ACTIVATE  TEST.ACTIVATE
```

ON.ACTIVATE assigned the program **TEST.ACTIVATE** to **EX.WINDOW**.

Activate **EX.WINDOW** by either clicking in it or using **SELECT.WINDOW**. When the window is activated, it will run the program **TEST.ACTIVATE**, which displays the message "Window Activated!!", and executes **WORDS**. When **WORDS** has completed, it will pass control back to the MacFORTH interpreter, which will display "ok".

Now click down in another window. When the window is deactivated, **TEST.ACTIVATE** will be executed again, but this time a false flag is passed, indicating the window is being deactivated. The message "Window Deactivated!!" will be displayed, and control is passed to the newly selected window.

Window Function Template

Each program assigned to a window should be similar to the following template:

```
: WINDOW.FUNCTION  ( activate flag -- )
    IF    <activate code>
    ELSE  <deactivate code>
    THEN  ;
```

This is discussed in more detail in the Windows chapter.

Multiple Windows

The number of windows you can have and display at the same time is limited only by the amount of memory available. When a window is activated, its program will run until it completes or another window is activated.

Menus

Another important innovation of the Macintosh is the use of menus. Menus allow you to present a large number of options to the user while at the same time not requiring him or her to go through several layers of traditional menus or remember a large number of commands.

The menu examples presented in the previous chapter should have given you a good foundation for creating your own menus. For an in-depth discussion of menus, refer to the Menus chapter.

Sound Generation

The Macintosh supports a wide range of sound capabilities. MacFORTH provides access to the ROM sound driver for complex sounds (free form and 4 voice wave form) as well as versatile support for simple square wave tone generation.

Simple Tone Generation

In order to generate distinctive sounds to alert the operator or play simple melodies, MacFORTH provides the word **TONE**. **TONE** expects three things on the stack:

```
      duration\volume\frequency
```

Duration is expressed in increments of 1/60 of a second "ticks" and is in the range 0 through 256 (0-4.5 seconds).

Volume is expressed in a scale from 1 through 255, with 255 representing the loudest. The volume is also determined by the value you have chosen in the control panel.

Frequency is expressed in hertz * 10.

For example,

```
      60 128 1000 TONE
```

will generate a tone of 100 Hz at half volume for 1 second. Here are a few others to try:

```
      60 128 100 TONE
      60 128 10000 TONE
      120 64 30000 TONE
```

Detecting Sound in Progress

The word **?SOUND** lets you check to see if a tone or series of tones is currently being sounded.

Aborting Sound in Progress

The word **HUSH** allows you to abort any sounds currently being generated.

Rest Notes

A frequency of 0 waits the supplied duration with no sound output.

Note/Frequency Equivalence

The following table provides frequency equivalence for notes in an 8 octave human tempered scale:

Octave (frequency*10)

Note	0	1	2	3	4	5	6	7
C	164	327	654	1308	2616	5233	10466	20930
C*	173	348	693	1386	2772	5544	11087	22175
D	184	367	734	1468	2937	5873	11747	23493
D*	194	389	778	1556	3111	6223	12445	24890
E	206	412	824	1648	3296	6593	13185	26390
F	218	437	873	1746	3486	6985	13969	27938
F*	231	462	925	1850	3700	7700	14800	29600
G	245	490	980	1960	3920	7840	15680	31360
G*	260	519	1038	2072	4153	8300	16612	33224
A	275	550	1100	2200	4400	8800	17600	35200
A*	291	583	1165	2331	4662	9323	18647	37293
B	309	617	1235	2469	4939	9878	19755	39511

Arrays

Arrays are simple! An array is just an area of memory you set aside to store data in. You decide what is kept in the array and how the data is accessed. This can range from a very simple, one dimensional array storing single characters to a multi-dimensional array storing complex data items.

Creating an Array

To create an array, you simply assign a name to an area of memory and allocate the amount of space you need. Use **CREATE** to name the area and **ALLOT** to allocate the space. For example, to allocate space for an array which will hold the ages of 10 of your employees, you would execute:

```
   CREATE AGES  10 ALLOT
```

You now have an area of memory allocated (10 bytes) to the array **AGES**. Since the values in this array will each fit into 1 byte (0-255), only 10 bytes are needed.

If you wanted to create another array which would keep track of their salaries (in the range $15,000-$75,000), each element in the array would require 4 bytes (a 32-bit integer). You could create an array named **SALARIES** for this information:

```
   CREATE SALARIES  10 4* ALLOT
```

Why did we specify 10 4* instead of 40? Which do you think more clearly describes 10 elements, each 4 bytes long?

Initializing the Array

You can initialize an array in many ways. The MacFORTH words **ERASE** and **BLANKS** are convenient for zero and blank filling arrays. Try zero filling the **AGES** array now by executing:

```
   AGES 10 ERASE
```

Refer to the MacFORTH Glossary entry **FILL** for a general purpose word to fill memory with any character.

Accessing Data in an Array

Given the base address of the array (given by its name), you can add the appropriate offset to calculate the address of any element in the array. For example, to get the first element in the **AGES** array (with subscript 0), you would execute:

```
   AGES C@ .
```

and you'll see that the value is zero. To read the second element in the **AGES** array (with subscript 1), you would execute:

```
   AGES 1+ C@  .
```

and so on. Remember, the subscript of an element is zero based, meaning that the first element is subscript 0, the second, subscript 1, the third, subscript 2, and so on. This is logical if you think of the start of the array as the base of the array, and each element is just an offset from the base. The first element is located at the base, the second is located one up from the base, and so on...

Storing data in the **AGES** array is just as easy. For example, to store 27 in the third element (subscript 2), you would execute:

```
   27  AGES 2+ C!
```

Since each element in the **AGES** array is one byte long, calculating the address of any element is as easy as adding its subscript to **AGES**. In the **SALARIES** array, it is almost as easy.

Each element in **SALARIES** is 4 bytes, so you need to multiply the subscript by 4 (the length of each element) to get the address of any element in the array. For example, to get the first element (subscript 0), you would execute:

```
   SALARIES @ .  ( or )  SALARIES  0 4* +  @ .
```

To get the third element (subscript 2), you would execute:

```
   SALARIES  2 4* + @  .
```

Why did we use 2 4* + instead of 8? The first expression (2 4*) tells you that you were getting the second 4-byte element, the second (8) is ambiguous.

Here's a word to display each element in the **AGES** array:

```
   : SHOW.AGES  ( --- )
       10 0  DO  CR I .  ." = "  AGES  I+ C@ .  LOOP  ;
```

or, each element in the **SALARIES** array:

```
   : SHOW.SALARIES  ( --- )
       10 0 DO  CR I .  ." = "  SALARIES  I 4* +  @  .  LOOP  ;
```

You've noticed by now that MacFORTH doesn't check to see if you are using a valid subscript when accessing an array. This saves the tremendous overhead of checking each and every subscript each and every time an element in the array is accessed. It is your responsibility to check the values when necessary.

As we said, what you do with an array and the data you keep in it is completely up to you. Arrays in MacFORTH are free-form areas of memory. If you are new to FORTH programming, some interesting words to remember when using arrays (or any time you are manipulating memory) are:

```
      @     W@      <W@     W!      C@      C!      CMOVE
      FILL  ERASE   BLANKS
```

Memory Allocation

Memory in the Macintosh is allocated from a pool of available memory called the "heap." Although most memory allocation is handled automatically by MacFORTH, there are two areas which you must be aware of and explicitly control: the object and current vocabulary areas. We leave the allocation of memory up to you in order to give you more control of this resource.

When a new word is created in MacFORTH, the name is placed in the current vocabulary area (usually the FORTH vocabulary). The parameter field (which includes data, memory addresses or 68000 instructions) is placed in the object area.

If you need more room while compiling a program and you get one of the following error messages:

```
   VOCABULARY FULL!
```

or

```
   OBJECT FULL!
```

you will need to resize the appropriate space.

Displaying the Amount of Memory Available

You don't have to wait until you get one of these errors in order to resize the appropriate space. You can monitor both areas as you add definitions by executing the word **ROOM** . See how much room you have allocated and available now by executing

```
   ROOM
```

and you will see the display:

```
   aaaa  OF  bbbb  Object Bytes Available
   cccc  OF  dddd  Current Vocabulary Bytes Available
                eeee  Heap Bytes Available
```

aaaa is the number of unused object bytes available and bbbb is the total number of object bytes allocated. Subtracting aaaa from bbbb will give you the number of object bytes used).

cccc is the number of unused bytes in the current vocabulary and dddd is the total number of bytes allocated. Subtracting cccc from dddd will give you the number of current vocabulary bytes used).

eeee is the amount of heap space available. This tells you how much memory is available for use. This is actually the maximum amout of available heap space, including purgable resources (like fonts). If you allocate all of this space, the current font will default back to the system font

Resizing Memory

You explicitly specify the amount of space to be used by either the object space or current vocabulary space. This way you can increase or decrease either as you needs require.

To resize the object space, use the command **RESIZE.OBJECT**, specifying the amount of space to allocate to the area. For example, to allocate 10,500 bytes to the object area you would execute:

```
   10500  RESIZE.OBJECT
```

To resize the current vocabulary space, use the command RESIZE.VOCAB, specifying the amount of space to allocate to the area. For example, to allocate 9500 bytes to the current vocabulary space you would execute:

```
   9500  RESIZE.VOCAB
```

After resize either memory area, it is wise to verify the change by executing ROOM. You will notice the amount of heap bytes available change as well as the amount of space allocated to the area modified.

You can also resize the vocabulary and object area with **MINIMUM.VOCAB** and **MINIMUM.OBJECT** respectively. Suppose you need at least 1500 bytes of object space to load a particular program. You could execute **ROOM** and calculate the appropriate value for **RESIZE.OBJECT**. **MINIMUM.OBJECT** will do all that work for you. All you would need to do is execute:

```
   1500 MINIMUM.OBJECT
```

If you try to allocate more space than is available, or to shrink either memory area smaller than its current contents, MacFORTH will issue an error message. Refer to the Error Handling chapter for more information when one of these errors occurs.

Chapter 6: Graphic Results

Overview

This chapter discusses how to produce graphics images on the Macintosh. It is intended to introduce you, through examples, to each of the features of the MacFORTH graphics package. In our examples, we frequently use the analogy of drawing with a pen on a piece of paper for clarity.

Preparations

It's a good idea to complete this chapter in one sitting (it should take you 20-30 minutes). If you have read straight through the preceding chapters you may want to take a break, then come back to this chapter.

As you go through this chapter, let your imagination run free. Explore. Be creative! Our examples are intended to trigger your own examples. Of all the wonderful things that Macintosh graphics package is, perhaps the most important feature is that it's <u>fun</u> to use!

QuickDraw™: A Solid Base

QuickDraw is the underlying graphics package from which the Macintosh User Interface (ie. menus, windows, etc.) is constructed. Written by Bill Atkinson, QuickDraw represents many major innovations in graphics software technology.

QuickDraw lives up to its name! It's very fast. You can do good quality animation, fast interactive graphics, and complex yet speedy text displays using the full features of QuickDraw. Using QuickDraw, you can divide the Macintosh screen into a number of individual windows. Within each window you can draw:

- Straight lines of any length and width.

- Text characters in a number of proportional and fixed spaced fonts, with variations that include boldface, italics, underline, shadow, and outline.

- A variety of shapes, either solid or hollow, including rectangles with or without rounded corners, ovals, arcs, and wedges.

- An arbitrary shape or collection of shapes, either solid or hollow.

In addition, QuickDraw has some other abilities that you won't find in many other graphics packages. These features take care of most of the "housekeeping" -- the trivial but time-consuming and bothersome overhead that's necessary to keep things in order:

- The ability to define many distinct windows on the screen, each with its own complete drawing environment -- its own coordinate system, drawing location, character set, location on the screen, and so on. You can easily switch from one window to another.

- Full and complete "clipping" to arbitrary areas, so that drawing will occur only where you want. You don't have to worry about accidentally drawing over something else on the screen, or drawing off the screen and destroying memory.

MacFORTH provides you with direct access to most of the features of QuickDraw. Upon this strong foundation we have built a two dimensional graphics package capable of translating pictures and images which are expressed in natural user coordinates (ie; feet, miles, furlongs, centimeters) into actual images on the screen. The images that you create may be offset, rotated, and scaled with respect to the window in which you are drawing.

Your Window, Your Canvas

All drawing occurs within the content region of a window. The content region of a window is the area inside the window excluding the title bar, grow box and any control bars. Each window is a complete and separate drawing environment that defines how and where graphic operations will have their effect. Each window has it's own coordinate system, drawing pattern, background pattern, pen size and location, and character font size and style. You may instantly switch between windows for graphic output.

The MacFORTH Window

In the following examples, you will use the MacFORTH window for graphics output. Although both interactive transactions with MacFORTH and graphics output will occur on the same window, we will later discuss how to do each in separate windows.

Now, resize the MacFORTH window to take up most of the available desktop space. (If you don't understand how to do this, run the Guided Tour to Macintosh and review the preceding chapters).

Graphics Initialization

Before you begin drawing, execute

```
    GINIT
```

This will restore the state of the graphics system to it's default state. If, while trying the examples in this chapter, you become confused as to what is going on (e.g. drawing in white ink on a white background) use **GINIT** to restore the system to a known state – black ink on white background. You will notice that the cursor moves immediately to the upper left corner of the window.

The QuickDraw Coordinate System

GINIT also resets coordinate interpretation to QuickDraw native mode (which we call "native coordinates"), and places the pen at 0,0. Let's move the origin to the center of the screen and display the xy-axis. Execute

```
     CENTER   XYAXIS
```

Take Note!!!! QuickDraw native coordinates are different from the normal Cartesian coordinates that you may have learned in school:

Cartesian Coordinate Sytem

Here's a diagram of the coordinate system most people learned in school. As you would expect, increasing y-axis values progress upward, increasing x-axis values progress to the right.

```
                        Higher 'Y'
                           /\
                           |
                           |
                           | (0,0)
Lower 'X'  <----------------------> Higher 'X'
                           |
                           |
                           |
                           \/
                        Lower 'Y'
```

QuickDraw Coordinate System
Here's a diagram of the QuickDraw coordinate system. Notice the difference? In QuickDraw, as in Cartesian coordinates, x-axis values progress to the right. The difference is that y-axis values progress downward.

```
                     Lower 'Y'
                        /\
                         |
                         |
                         |
Lower 'X'  <--------------------> Higher 'X'
                         | (0,0)
                         |
                         |
                        \/
                     Higher 'Y'
```

When you executed
```
      CENTER  XYAXIS
```

you directed MacFORTH to center the coordinate system and draw an xy-axis. Look carefully at the xy-axis on the screen. The '+' sign for the y-axis (up an down direction) is at the bottom, not the top (where it would be in Cartesian coordinates).

GINIT restores the position of the point (0,0) to the upper left corner of the window (which you changed by executing the word **CENTER**). The diagram below shows how your window relates to the coordinate system in native QuickDraw coordinates:

```
 ( top left corner of screen --¬  )
                                V
                                -----------------> higher 'x'
                                | --------------
                                | | 0,0          |
                                | |    Mac       |
                                | |  Window      |
                                | |  or Page of  |
                                | |    Text      |
                                | |--------------|
                                |
                               \/
                               higher 'y'
```

Execute the following example:

```
      10 10 MOVE.TO    50 50 DRAW.TO
```

This will move the pen to 10, 10 and draw a line to 50, 50. Notice the line slopes downward.

MOVE.TO expects two values on the stack (the x and y coordinate of a point), and moves the starting point for drawing to that position. If you think of drawing lines with a pen, **MOVE.TO** simulates lifting the pen off of the paper and moving it to the specified location.

DRAW.TO expects two values on the stack (the x and y coordinate of a point), and draws a line from the current point to the specified point. The new location becomes the starting point for the next operation. If you think of drawing lines with a pen, **DRAW.TO** simulates keeping the pen down as you move it to the specified location.

The Magic of QuickDraw

Most major innovation is the result of relaxing traditionally accepted constraints and discovering new ways of looking at a problem. By relaxing the Cartesian y-axis constraint, Bill Atkinson was able to construct a mathematically pure model capable of expressing a two dimensional coordinate system on bit-mapped graphics screens. Much of the startling performance of the QuickDraw package is the result of the far simpler arithmetic relationships between points in graphics memory and QuickDraw coordinates rather than Cartesian coordinates.

But don't panic! You don't have to learn a new method of drawing points if you don't want to. MacFORTH allows you to express points in the Cartesian coordinate system if you prefer. Try the following example:

```
      CARTESIAN  ON         ( specify the Cartesian system )
      PAGE                  ( clear the window )
      CENTER                ( center the xy axis in the window )
      XYAXIS                ( display the xy axis )
      10 10 MOVE.TO  50 50 DRAW.TO   ( draw a line )
```

The line that was drawn slopes upward, just as you would expect it to when drawn in a Cartesian coordinate system. To go back to the native QuickDraw coordinate system, execute:

```
      CARTESIAN OFF
```

That's how easy it is to change between the two coordinate systems!

Range of Coordinates

Coordinate values are between -32768 and +32767 for both x and y. Based upon where you place the axis origin, points that are calculated to appear within the window will be displayed; all others are not. Execute:

```
      CARTESIAN ON
      CENTER       ( discussed later )
      10 10 MOVE.TO  1000 1000 DRAW.TO
```

Notice that the line was drawn right off of the window. Now execute:

```
      20 10 MOVE.TO  100000 100000 DRAW.TO
```

Numbers greater than 32767 "wrap around" to the negative end of the coordinate system. Coordinate values outside the range ±32767 are invalid. Refer to the "Scaling to User Coordinates" section of this chapter for how to deal with larger numbers.

A Handy Tool

Enter the following definition to save yourself some typing:

```
      : CLEAN  ( --- )  PAGE  CENTER  CARTESIAN ON  XYAXIS  ;
```

Try it out now, execute:

```
      CLEAN
```

**** Programming Tip **** When writing and testing MacFORTH programs, any sequence of commands you use a lot should be defined and given a name.

In examples in the rest of this chapter, we will ask you to execute **CLEAN** to be sure you are in a known state. Remember, if you re-boot MacFORTH, or **FORGET** the word **CLEAN**, you will need to re-enter the definition. From now on we'll just use **CLEAN** to clean up the display and redraw the xy-axis.

Here's a quick summary of the commands we have presented so far:

CARTESIAN OFF	Sets mode to native QuickDraw coordinates
CARTESIAN ON	Sets mode to cartesian coordinates
CENTER	Positions the xy origin in the center of the window
CLEAN	Wipes the display and places the xy-axis in Cartesian coordinates on the screen (this word is <u>only</u> present if you enter the definition given on the previous page)
DRAW.TO	Draws with the pen to the specified location from the current location (for now use MOVE.TO before every DRAW.TO on the same line)
GINIT	Reverts to Macintosh native coordinates and places the xy origin in the upper left corner of the window
MOVE.TO	Moves the pen to the specified location
PAGE	Clears the screen
XYAXIS	Displays the xy-axis

Line Drawing

As you have seen, lines are defined by two points: the current pen location and a destination location. When drawing a line, QuickDraw moves the pen (actually the top left corner of the pen) along the calculated line from the current location to the destination.

If you draw a line to a location outside your window the pen location will move there, but only the portion of the line that is calculated to be inside the window will actually be drawn. This is true for all drawing procedures.

Window Pen Characteristics

The graphics "pen" associated with each window has the following unique characteristics:

- a location
- a size and shape
- a drawing pattern
- a drawing mode

Pen Location

The pen location is a point in the coordinate system of the window and is where QuickDraw will begin drawing the next line, shape, or character. Within the range of coordinates there are no restrictions on the location or placement of the pen. Remember, if you position the pen outside of the window, you won't see part of the next line or shape drawn (if you leave it there).

As you have already seen, **MOVE.TO** positions the pen at the specified location, and **DRAW.TO** draws from the current location to the specified point.

Notice the emphasis that **DRAW.TO** draws from the current location. To illustrate this point, execute the following example (on three separate lines):

```
CLEAN
10 10 MOVE.TO
100 100 DRAW.TO
```

What happened?? Let's try it again, one step at a time. Execute:

```
CLEAN
```

You see that the window was cleared, the xy-axis was displayed, and the "ok" was displayed in the upper left corner. Next, execute:

```
10 10 MOVE.TO
```

look at the xy-axis, where the point (10,10) is. See the "ok"? This tells you where the pen location was moved to. After MacFORTH processed the command, it output the "ok" and then moved the pen to the start of the next line (at the current cursor position). Each time you enter a character, the pen location is moved to the right (at the position of the cursor). So, when you exuecte:

```
100 100 DRAW.TO
```

Where was the current location when the command was processed? At the cursor position, just to the right of the **DRAW.TO** command.

This is why you were given examples with **MOVE.TO** and **DRAW.TO** on the same line. Now try:

```
      CLEAN
      10 10 MOVE.TO  100 100 DRAW.TO
```

and you'll see the line you expected. Remember, the current pen location is changed when MacFORTH finishes what you just asked <u>in interactive</u> (or interpretive) mode. While running a program, your pen will move only to where you specify.

<u>Pen Drawing</u>

You've already seen how to draw using the commands **MOVE.TO** and **DRAW.TO**. If you already know the starting and ending positions of a line, you can simplify drawing it with the word **VECTOR**. **VECTOR** draws a line between 2 specified points. For example, to draw the same line two different ways, you could execute either:

```
      0 0 MOVE.TO  100 100 LINE.TO
```

or:

```
      0 0 100 100 VECTOR
```

If you only want to display a single dot, you can use the word **DOT**. **DOT** expects the x and y coordinate of the dot you want to display. Try displaying a few dots by executing:

```
      CLEAN
      20 20 DOT
      10 10 DOT
      30 50 DOT
      -10 35 DOT
```

In MacFORTH, it is easy to define your own shapes. For example, here's a definition to draw a small box (you may want to edit this definition into a block and then load it):

```
      : BOX  ( --- |  draws a square on the screen )
          10  10 MOVE.TO  -10  10 DRAW.TO
         -10 -10 DRAW.TO   10 -10 DRAW.TO
          10  10 DRAW.TO  ;
```

Now try it out by executing:

```
      CLEAN  BOX
```

Feel free to modify the definition for **BOX** to create some graphics shapes of your own. You may want to increase the size of the box, or make a diamond, or whatever...

Pen Size and Shape

The pen is rectangular in shape, and has a user-definable width and height. The default size (reset by GINIT) is a 1 by 1 bit square; the width and height can range from 0, 0 (no pen show), all the way up to 32,767, 32,767 (a very, very thick pen). If either the pen width or the pen height is less than 1 the pen will not draw on the screen.

You can modify the size of a pen by specifying its width and height in terms of dots to the word **PENSIZE** . For example,

```
      5 10 PENSIZE
```

would specify a pen 5 dots wide and 10 dots high. To see what effect this has, try a few examples:

```
      CLEAN
      1 1 PENSIZE   100 100 DOT
      5 10 PENSIZE  50 50 DOT
      1 1 PENSIZE   0 0  -50 -50 VECTOR
      10 3 PENSIZE  0 0 100 -100 VECTOR

      CLEAN
      1 1 PENSIZE BOX

      CLEAN
      1 5 PENSIZE BOX

      CLEAN
      5 1 PENSIZE BOX

      CLEAN
```

The pen appears as a rectangle with its top left corner at the pen location; it hangs below and to the right of the pen location. You can see this by executing:

```
      10 10 PENSIZE  0 0 DOT
```

Think of the coordinate plane as a grid. Individual dots are separated by the lines of the grid. As the pen moves across the grid, only dots below and to the right of the pen which fall within the pen size rectangle are affected by the pen.

Pen Mode and Pen Pattern Characteristics

The pen mode and pen pattern characteristics determine how the bits under the pen are affected when lines or shapes are drawn. The pen pattern is an 8-bit by 8-bit pattern that is used like the "ink" in the pen. Five patterns are predefined: (WHITE, LTGRAY, GRAY, DKGRAY, BLACK). Try a few examples:

```
      CLEAN
      10 10 PENSIZE
      GRAY PENPAT
      -100 100 -10 10 VECTOR
      DKGRAY PENPAT
      -120 100 -20 10 VECTOR
```

For fun try:

```
      CLEAN
      CREATE <BRICKS>
      HEX  808080FF ,  080808FF ,  DECIMAL

      CLEAN  20 20 PENSIZE
      <BRICKS> PENPAT
      10 10 100 100 VECTOR
```

Some of the other patterns that we have worked with include:

```
      HEX
       CREATE <SPIRAL>      00FE02FA ,  8ABA82FE ,
       CREATE <CHECKS>      CCCC3333 ,  CCCC3333 ,
       CREATE <BIG.CHECKS>  F0F0F0F0 ,  0F0F0F0F ,
       CREATE <SIGMAS>      007C4420 ,  1020447C ,
       CREATE <WEAVE>       F8742247 ,  8F172271 ,
       CREATE <MARBLES>     77898F8F ,  7798F8F8 ,
       CREATE <WAFFLES>     BFC0BFBF ,  B0B0B0B0 ,
      DECIMAL
```

As you can see, the pen pattern is used to fill in the bits that are affected by the drawing operation.

Pen Mode

The pen transfer mode determines how the pen pattern is to affect those dots which pass under the pen. When the pen draws, QuickDraw first determines what bits of the bit map will be affected and finds their corresponding bits in the pattern. It then does a bit-by-bit evaluation based on the pen mode, which specifies one of eight boolean operations to perform. The resulting bit is placed back into memory.

The word **PENMODE** allows you to specify the current pen mode. Choose the pen mode from one of the following constants (each mode specified below is represented by a MacFORTH constant of the same name):

Mode	Dot was Black	Dot was White
PATCOPY	Force Black	Force White
PATOR	Force Black	No Change
PATXOR	Invert	No Change
PATBIC	Force White	No Change
NOTPATCOPY	Force White	Force Black
NOTPATOR	No Change	Force Black
NOTPATXOR	No Change	Invert
NOTPATBIC	No Change	Force White

For each type of mode, there are four basic operations -- Copy, Or, Xor, and Bic. The Copy operation simply replaces the dots in the destination with the dots in the pattern , "painting" over the destination without regard for what is already there. The Or, Xor, and Bic operations leave the destination dots under the white part of the pattern or source unchanged, and differ in how they affect the dots , thus "overlaying" the destination with the black part of the pattern . Xor inverts the dots under the black part. Bic erases them to white.

Each of the basic operations has an alternate form in which every pixel in the pattern is inverted before the operation is performed. Each mode is defined by name as a constant in MacFORTH, e.g. (PATCOPY) . The best way to understand each mode is to experiment with them. Try the following examples to start with, and then try some of your own:

```
CLEAN
<BRICKS> PENPAT
PATXOR PENMODE
20 20 PENSIZE
0 0 100 -100 VECTOR

BLACK PENPAT
0 4 50 -50 VECTOR
```

Text Output

MacFORTH allows you to output in any text font, style, mode, or size available on the Macintosh. Text drawing does not use the pensize pen pattern or pen mode, but it does use (and modify) the pen location. Each character is placed to the right of the current pen location, with the left end of its base line at the pen's location. The pen is moved to the right to the location where it will draw the next character. Enter:

```
      GINIT  CLEAN
      100 100 DRAW.TO
```

All text drawn on the screen is drawn by QuickDraw. As a result, when the word **DRAW.TO** was echoed back to the user as it was typed in, the current point advanced and was left at the end of the text. The line was then drawing from that point to 100 100 (from the center of the window).

Text echoed back to MacFORTH is a special case, and only effects graphics drawn interactively in the MacFORTH window. When a carriage return or line feed is output, MacFORTH determines where to put the next line of text. Text advances down along the QuickDraw native Y coordinate until the next line would be partially off of the window. MacFORTH then scrolls the window up to make room for the new line. Enter:

```
      CLEAN
       100  100 MOVE.TO  ." Now is the time "
      -100 -100 MOVE.TO  5  .
```

To move text around the screen, use **MOVE.TO** and then ouput the text. If you attempt to output a line feed at a point which is not currently in the window, MacFORTH will force it back onto the screen. This is so that all error messages will appear on the display.

Any text which occurs within a window is drawn according to the currently specified font, style, transfer mode and size. QuickDraw can draw characters as quickly and easily as it draws lines and shapes, and in many prepared fonts.

Character Font

A character font is defined as a collection of bit images: these images make up the individual characters of the font. The characters can be of unequal widths (proportional space characters). A font can consist of up to 256 distinct characters, yet not all characters need be defined in a single font. Each font contains a missing symbol to be drawn in case of a request to draw a character that is missing from the font (usually □ -- a hollow rectangle). Each font is assigned a specific reference number. If you have deleted any fonts from the MacFORTH disc (as explained in the Macintosh Users manual provided with your computer), they won't be available from MacFORTH. The word **TEXTFONT** allows you to specify the current text font. Choose the text font from one of the following values (no MacFORTH constants are provided for the text fonts):

Font	Value
Chicago	0 (System font)
Application	1 (New York)
New York	2
Geneva	3
Monaco	4 (fixed space -- the default MacFORTH font)
Venice	5
London	6 (Gothic)
Athens	7
San Francisco	8 (ransom notes)
Toronto	9

For example, those of you who are hooked on television police shows will recognize:

```
CR 8 TEXTFONT ." Have your goldfish, send cash or tartar sauce"
4 TEXTFONT
```

And English history buffs will think of:

```
CR 6 TEXTFONT  ." King Richard III"
```

To return to the normal MacFORTH system font execute:

```
4  TEXTFONT
```

To read the value of the currently selected textfont, execute:

```
GET.TEXTFONT .
```

Text Style

The text style controls the appearance of the font. The following styles are available: bold, italic, underline, outline, shadow, condense, and extend. You can apply these either alone or in combination. Most combinations usually look better on a larger character size.

If you specify **bold,** each character is repeatedly drawn one bit to the right an appropriate number of times for extra thickness.

Italic adds an italic slant to the characters. Character bits above the base line are skewed right; bits below the base line are skewed left.

Underline draws a line below the base line of the characters. If part of a character descends below the base line (ie: p) the underline is not drawn through the dot on either side of the descending part.

You may specify either outline or shadow. Outline makes a hollow outlined character rather than a solid one. With shadow, not only is the character hollow and outlined, but the outline is thickened below and to the right of the character to achieve the effect of a shadow. If you specify bold along with outline or shadow, the hollow part of the character is widened. For both of these type styles, the text mode (discussed next) **must** be **SRCOR** or **SRCXOR**.

Condensed and extended affect the horizontal distance between all characters, including spaces. Condensed decreases the distance between characters and extended increases it.

The word **TEXTSTYLE** allows you to specify the current text style. Choose the text style from one of the following constants (each style listed is represented by a MacFORTH constant of the same name):

Style	Bit#	Hex Value
PLAIN	n/a	0
BOLD	0	1
ITALIC	1	2
UNDERLINE	2	4
OUTLINE	3	8
SHADOW	4	10
CONDENSED	5	20
EXTENDED	6	40

For example, try:

```
     BOLD  TEXTSTYLE  ." Sample "
     BOLD  UNDERLINE +  TEXTSTYLE   ." Sample "
```

To read the current text style, execute

```
      GET.TEXTSTYLE .
```

For example, to enhance the current text style with bold face, you would execute:

```
      GET.TEXTSTYLE  BOLD +  TEXTSTYLE
```

Reset the text style to the default (plain setting) enter:

```
      PLAIN  TEXTSTYLE
```

Text Mode

The text mode controls the way characters are placed on a bit image. It functions much like a pen mode: when a character is drawn, QuickDraw determines which bits of the bit image will be affected, does a bit-by-bit comparison based on the mode, and stores the resulting bits into the bit image.

The word **TEXTMODE** allows you to specify the current text mode. Chose the text mode from one of the following constants (each mode listed is represented by a MacFORTH constant of the same name):

```
      SRCCOPY     (source copy)
      SRCOR       (source or)
      SRCXOR      (source exclusive or)
      SRCBIC      (source bit clear)
```

The best way to understand each text mode is to experiment with each. The default text mode is **SRCXOR**. Try the following examples to get started, then continue with a few of your own:

```
      SRCXOR TEXTMODE  ( be sure its the default)
      PAGE
      100 100 MOVE.TO  ." HELLO"
```

(press Return an extra time here to avoid overwriting the previous line)

```
      101 101 MOVE.TO ." HELLO"
```

(again, press Return a few times to avoid overwriting the previous lines)

```
      SRCCOPY TEXTMODE
      100 100 MOVE.TO  ." HELLO"
```

Return to the default text mode when you finish experimenting by executing:

```
      SRCXOR TEXTMODE
```

Finally, clean up the window by executing:

```
      PAGE
```

Text Size

The text size specifies the type size for the font in points ("points" here is a printing term meaning 1/72 inch). Any size may be specified. If the Macintosh Font Manager does not have the font in a specified size, it will scale a size it does have in order to produce the size desired. A value of 0 directs the Font Manager to select the size from among those it has for the font; it will choose whichever size is closest to the system font size (12-point).

The word **TEXTSIZE** allows you to specify the text size. For example, to set the text size to be 20, you would execute:

```
      20 TEXTSIZE
```

You can read the current text size by executing

```
      GET.TEXTSIZE .
```

Here are a few examples to try:

```
      34 TEXTSIZE
      21 TEXTSIZE
      5  TEXTSIZE
      10 TEXTSIZE
```

and finally, return to the default text size by executing:

```
      12 TEXTSIZE
```

You can see that when you increase the size of the font, it overwrites letters on previous lines. This is due to the line height for output, explained next.

Line Height

The line height determines how far to advance down the page or scroll up when a linefeed is encountered. Line height should normally be a little larger than the text size (usually 3 points larger).

The word **LINE.HEIGHT** allows you to specify the line height, **GET.LINE.HEIGHT** returns the current line height. Here are a few examples to try:

```
      15 LINE.HEIGHT  12 TEXTSIZE  ( the default values)
      20 LINE.HEIGHT
      30 LINE.HEIGHT
      15 LINE.HEIGHT
```

Execute **GINIT** to restore text size and line height.

Moving the Origin

MacFORTH allows you to move the origin for graphics output around on your window. As you have already seen, **XYAXIS** draws the xy-axis around the center of the coordinate system. Execute

```
      PAGE
      CENTER
      CARTESIAN ON
      XYAXIS
```

and you'll see the xy-axis drawn in the center of your window. You can also select the upper and lower left corner of the window as the origin. Try:

```
      PAGE
      LOWER.LEFT  XYAXIS
```

and you'll see the xy-axis (only the upper right quadrant) displayed in the lower left corner of your window. Now try:

```
      PAGE
      UPPER.LEFT  XYAXIS
```

and you'll see the xy-axis (only the lower right quadrant) displayed in the upper left corner of your window.

From any of these new origins, you can draw graphics just as you did from the center of the window. As before, only those points that are inside the bounds of the window will be displayed.

You can take moving the xy origin one step further and position it anywhere (inside <u>or</u> outside the window). The word **XYOFFSET** allows you to express the offset from the upper left corner of your window <u>in native QuickDraw coordinates</u> for your xy origin. For example, to position your origin 150 dots from the left and 75 dots from the top of your window (the content region), you would execute:

```
      150 75 XYOFFSET
```

Now verify this by executing:

```
      XYAXIS
```

Try out your new origin location by executing:

```
      PAGE
      XYAXIS
      0 0 100 -100 VECTOR
```

and you can see that the origin has indeed been moved.

Background Pattern

The default pattern for the background of a given window is white. You can change this to any pattern you like using the word **BACKPAT**. Here are a few examples to try (the word **PAGE** simply fills the background with the current background pattern):

```
      SRCCOPY TEXTMODE  ( so you can see what you type )
      DKGRAY   BACKPAT  PAGE
      <BRICKS> BACKPAT  PAGE
      GRAY     BACKPAT  PAGE
      BLACK    BACKPAT  PAGE
```

And finally, return to the default background pattern by executing:

```
      WHITE BACKPAT  PAGE
      SRCXOR  TEXTMODE
```

QuickDraw Shapes

QuickDraw supports a number of predefined shapes:

Rectangles
Ovals (includes circles)
Rounded Corner Rectangles
Arcs (includes wedges)

Each shape may be **FRAME**d, **PAINT**ed, **CLEAR**ed, **INVERT**ed or **PATTERN**ed.

The outlines of **FRAME**d shapes are drawn with the current pen size, shape mode, and pattern. As the pen traces just inside the boundaries of the shape, dots to the right and below the pen (within the pen size) are modified. The pen location is not affected.

Dots within the boundaries of **PAINT**ed shapes are filled with the current pen pattern and mode. The pen location is not effected.

Dots within the boundaries of **CLEAR**ed shapes are set to the background pattern in pattern copy mode.

Dots within the boundaries of **INVERT**ed shapes are toggled. Dots that were black become white and white dots become black.

Dots within the boundaries of **PATTERN**ed shapes are filled with the supplied pattern in pattern copy mode.

Rectangles
Rectangles are defined by two points at opposing corners. For example:

```
      GINIT  PAGE
      50 50 200 200 FRAME RECTANGLE
      200 100 100 200 INVERT RECTANGLE
      CARTESIAN ON

      CENTER PAGE
      XYAXIS
      -100 -100 100 100 GRAY PATTERN RECTANGLE
```

If you still have bricks around, try:

```
      PAGE
      -130 -200 130 -100 <BRICKS> PATTERN  RECTANGLE
```

(If you have forgotten **<BRICKS>**, execute:

```
      HEX
        CREATE <BRICKS>  808080FF ,  080808FF ,
      DECIMAL
```

and then try the previous example again.)

The stack arguments for a rectangle are:

```
      ( X1\y1\x2\y2\[pattern]\mode -- )
```

Notice the top two stack items. The pattern parameter is optional. This convention holds true for the standard QuickDraw patterns. If you use one of the standard modes, you don't specify a pattern. Standard QuickDraw modes are:

```
      FRAME  PAINT  CLEAR  INVERT
```

(as explained in the beginnning of this section). In the previous example, to draw a framed rectangle, you executed:

```
      50 50 200 200 FRAME RECTANGLE
```

If you use a pattern (like **WHITE**, **GRAY**, **DKGRAY**, **BLACK**, or one you have created -- like the **<BRICKS>** example), you need to supply the pattern address and specify the mode as **PATTERN**. In the previous example, to draw a gray rectangle, you executed:

```
      -100 -100 100 100 GRAY PATTERN RECTANGLE
```

Ovals

Ovals are drawn within a specified rectangle. A square rectangle results in a circle. For example:

```
CLEAN
0 0 200 100 INVERT OVAL

<BRICKS>  PENPAT
-20 -20 0 0 PAINT OVAL

DKGRAY BACKPAT
-100 0  100 100 CLEAR OVAL

BLACK PENPAT   WHITE BACKPAT

-150 -150 100 100 FRAME OVAL
```

The arguments to an oval are the same as those to a rectangle.

Rounded Corner Rectangles

A rounded corner rectangle is specified by a rectangle and the height and width of an oval which describes the corners.

For example:

```
CLEAN
50 50 120 120 20 10 INVERT  RRECTANGLE
-50 -50 20 20 5 5 FRAME  RRECTANGLE
```

The stack arguments for a rounded rectangle are

```
x1\y1\x2\y2\oval width\oval height\[pattern]\mode --
```

The oval width and height specify the oval the corners of the rectangle lie within. If this seems confusing, experiment with these two values on a rounded rectangle a few times -- a picture really is worth a thousand words!

Arcs and Wedges

Arcs are specified by an enclosing rectangle, and the starting angle of where the arc begins and the arc angle of the extent of the arc. The angles are treated modulo 360 and may be expressed in positive or negative degrees. A positive angle proceeds clockwise, a negative angle, counter clockwise. As with the rounded rectangles, this may seem confusing at first, but experimenting with a few makes them much clearer.

While you are experimenting, if you imagine the screen is the face of a clock:

```
  0            degrees is at 12:00
 90 (or -270) degrees is at  3:00
180 (or -180) degrees is at  6:00   ....... etc.
```

Arcs use the following stack arguments:

```
( x1\y1\x2\y2\start angle\arcangle\[pattern]\mode -- )
```

For example:

```
CLEAN
5 5 PENSIZE  BLACK PENPAT
20 20  100 100  90 120  FRAME  ARC
-100 -100  100 100  -45  240  GRAY  PATTERN  ARC
```

Relative Line Drawing

Frequently, groups of lines and dots are more related to each other than to their position on the screen. For example, the relationship between the lines that make up a particular character make more sense described in terms of each other. If the starting point is moved, then all relative lines and points can be redrawn without converting all of the points to the new location. For example:

```
CLEAN
: RBOX  ( --- | draw the sides relative to eachother )
    5 5 RMOVE  -10 0 RDRAW
    0 -10 RDRAW   10 0  RDRAW
    0 10  RDRAW ;

1  1  PENSIZE    PATCOPY  PENMODE
20  20  MOVE.TO  RBOX
40  30  MOVE.TO  RBOX
```

Here's a definition to draw a symbol for FORTH (you may want to edit this definition into an empty block in your work file):

```
: 4TH ( --- | draw an abstract symbol for FORTH )
    50 0 RMOVE   0 -20 RDRAW
   -30 0 RMOVE   0  40 RDRAW
   -20 0 RMOVE   0 -40 RDRAW
   -20 0 RMOVE   0  40 RDRAW
   -30 0 RMOVE   0 -20 RDRAW
   100 0 RDRAW    ;
```

Now move to any position and draw it. For example, try:

```
CLEAN
10 10 PENSIZE
100 100 MOVE.TO  4TH

1 1 PENSIZE
0 0 MOVE.TO  4TH

CLEAN
```

Scaling to User Coordinates

MacFORTH allows you to scale your drawings to arbitrary user coordinates. You can think of "scaling" as expressing values in terms of a percentage of another value. The word **XYSCALE** allows you to set the scale for both the x- and y-axis. The default xy scale is 100,100. Try a few examples to illustrate this:

For example:

```
      CLEAN XYAXIS

      10 10 MOVE.TO  4TH
      100 50 XYSCALE
      10 10 MOVE.TO  4TH
      100 200  XYSCALE
      10 10 MOVE.TO  4TH

      100 100 XYSCALE
      -50 -50 10 10  GRAY    PATTERN RECTANGLE
      25 150 XYSCALE
      -50 -50 10 10  DKGRAY  PATTERN RECTANGLE
```

If you wanted to draw the dimensions of a plot of land, expressed in feet, how would you map this to a Macintosh window? If the window is 100 x 100 dots and the maximum dimension of the plot of land was 500 feet, you could set the scale to:

```
      20 20 XYSCALE
```

and enter the coordinates in feet (each dot equals 5 feet). MacFORTH will automatically scale the data and display it for you.

Rotate to User Coordinates

MacFORTH also allows rotation of the coordinate system around the origin. By temporarily offsetting the origin, other objects may be rotated. The word **XYPIVOT** allows you to set the angle of rotation (in degrees) for the xy axis. For example, try rotating the **4TH** symbol 30 degrees:

```
      PAGE  CENTER
      30 XYPIVOT
      XYAXIS
      50 50 100 100 VECTOR
```

Now try:

```
      0 XYPIVOT
      XYAXIS
      50 50 100 100 VECTOR
```

and you can see how the first line and axis was rotated 30 degrees.

Here's a definition to spin the 4TH symbol by just changing the pivot:

```
      :  SPIN  ( --- |  spin the 4TH symbol )
         PAGE   PATXOR PENMODE
         CENTER   CARTESIAN ON   360  0
           DO    I  XYPIVOT
                0 0 MOVE.TO   4TH   0 0 MOVE.TO  4TH
           3  +LOOP   ;
```

By simply rotating the xy axis, you were able to rotate the **4TH** symbol without modifying the word **4TH** itself. Now try:

```
      5  5  PENSIZE  SPIN
      100 200  XYSCALE  SPIN
      200 100  XYSCALE  SPIN
```

Remember, only user defined shapes are rotated. QuickDraw shapes (using **RECTANGLE**, **OVAL**, and **RRECTANGLE**) are <u>not</u> rotated.

Point Pairs to Rectangle Coordinate Conversion

Converting between two points (x1,y1,x2,y2) and QuickDraw rectangles (top,left,bottom,right) is periodically necessary.

While most use of QuickDraw shapes for drawing purposes will occur in user coordinates (x1\y1\x2\y2), most toolbox operations actually expect point pairs (ie. a rectangle) to be expressed in QuickDraw coordinates (top\left\bottom\right). MacFORTH normally takes care of this conversion for you, and lets you deal in point coordinates. As your use of QuickDraw graphics and other functions which use them (such as windows and controls) increases, you will have to be more aware of both formats. The MacFORTH word **XY><TLBR** performs the conversion for you (either way -- given top\left\bottom\right, it returns x1\y1\x2\y2 and vice-versa).

Integer Trig Functions

Included in the MacFORTH graphics are two integer trig functions: sine and cosine. The words **SIN** and **COS** each convert an angle, expressed in degrees, into the angle's sine or cosine scaled up by 10,000. For example, the phrase

```
      45 SIN .
```

tells us that the sine of a 45 degree angle is .7071 (.7071 times 10,000 is 7071).

Define a word to plot one complete cycle of a sine wave. Since the input to **SIN** is an angle, we can set up a DO...LOOP that runs from 0 to 360, and use the index as the argument for **SIN**. This will return all the results from -10,000 to +10,000, since **SIN** is scaled up by a factor of 10,000. If our window is only 200 x 200, you clearly cannot fit a full scale sine wave on the display. By scaling the data, however, it will easily fit. Try the following example:

```
      :  WAVE    ( --- | draw a scaled sine wave )
          -1000  DUP  SIN  MOVE.TO
          1000  -1000  DO   I I SIN DRAW.TO  LOOP    ;
```

Now try:

```
      GINIT   CLEAN
      PATOR  PENMODE
      10 1 XYSCALE WAVE
```

Finding Out What's There

The word **GET.PIXEL** lets you find out the state of any dot on the screen. Given an xy position in QuickDraw coordinates, **GET.PIXEL** returns a true flag if the dot at that coordinate is black, a false flag otherwise. The xy coordinates are expressed in Quickdraw coordinates relative to the upper left corner of the screen. For example, to determine if the dot at 100,100 is on, you would execute:

```
      100 100 GET.PIXEL   .
```

Drawing to Other Windows

Anything that can be done in the graphics system window can be done in another window. (Resize MacFORTH window to a wide rectangle at the bottom of the screen like you did in the Getting Started chapter -- for figure 4.2). First, create a new window:

```
      NEW.WINDOW  EASEL
         40  40  200  350  EASEL  W.BOUNDS
         " EASEL "  EASEL  W.TITLE
      EASEL  ADD.WINDOW
```

Now click in the MacFORTH window to continue. The following definitions are used as a shorthand method for specifying the current window (your fingertips will thank us).

```
      : >E ( --- | select Easel window )    EASEL      WINDOW  ;
      : >M ( --- | select MacFORTH window ) SYS.WINDOW  WINDOW  ;
```

Note: If an error occurs while switching between windows, execute **>M** to return output to the MacFORTH window.

Now, resize the MacFORTH window so that both it and the **EASEL** windows are visible. Then try the following examples:

```
      >E  GINIT CENTER  XYAXIS  >M
      >E  10  10  50  50  GRAY  PATTERN  RECTANGLE >M

      : TWIST ( --- )
          GINIT  CENTER  CARTESIAN  ON
          360 0 DO I XYPIVOT  0 0 MOVE.TO  50 50 DRAW.TO  LOOP  ;

      >E  TWIST  >M
```

Try some examples of your own. Remember pulling down ABORT in the options menu or entering the ⌘A keystroke will return you to the MacFORTH system window.

Demo Programs

We have included some demo programs on your system disc. To load them, execute

```
      INCLUDE" Demo Blocks"
```

(or, you could double click the Demo Blocks icon from the finder). The demo programs are provided in source form so you can see the techniques used. Feel free to examine the demos (and make changes if you like). Have fun! We certainly did when we wrote them! To edit the demo source code, execute:

```
      USE" Demo Blocks"
```

and then edit whichever block you like. Block 1 of the file will give you a good idea of where specific demos are located.

Chapter 7: Menus

Overview

MacFORTH allows you to define and control menus easily. You can specify the order of the menus on the menu bar, their titles, and the items in each menu. Menu items can be selected via the mouse or command keys, disabled, highlighted, deleted, or even have their function changed.

This chapter discusses how to create, activate, de-activate, and delete menus from the menu bar. Using MacFORTH, you can create and use up to 31 menus simultaneously, each having up to 16 items; however, ten to twelve items per menu are all that will usually fit.

Menu Example

In order to simplify the presentation of this material, try the following example first. It creates and displays a sample menu, showing how easily menus can be defined. You may find it easier to edit this code into a blank block and then load it . That way if you make a typing error you don't have to re-type the whole example.

```
10  CONSTANT  EXAMPLE     ( for "example menu" )

: MY.MENU  ( --- | menu creation using menu id 10 )
    0  " My Menu "  EXAMPLE NEW.MENU ( create the menu )
          ( append the items to the list: )
         " Item 1<B<U;Item 2/2;Item 3<I("  EXAMPLE
APPEND.ITEMS
    DRAW.MENU.BAR     ( draw the menu bar )
   ( define the action to take place )
    EXAMPLE  MENU.SELECTION:
         CASE   1  OF   CR ." Item 1 Selected!"    ENDOF
                2  OF   CR ." Item 2 Selected!"    ENDOF
                3  OF   CR ." Item 3 Selected!"    ENDOF
         ENDCASE  0 HILITE.MENU ;
MY.MENU
```

Now try each of the items in "My Menu" by selecting them with the mouse (or as shown for item 2; ⌘2 -- hold down the ⌘ key and press 2).

Menu List

The menus displayed by MacFORTH are maintained in a "menu list." Each entry in the list has a menu id (a number assigned to a menu), and its position in the list determines the order of the menus in the menu bar. Note that this list is **not** maintained in numeric order, but in the order of **display** in the menu bar.

Menu Creation

The word **NEW.MENU** creates a new menu and inserts it into the menu list. **NEW.MENU** is used in the following form:

```
  <menu insertion point> <"menu title"> <menu id> NEW.MENU
```

So, in our example, we created a new menu, inserted it at the end of the menu list, called it "My Menu", and assigned it menu number 10 with the phrase (remember, **EXAMPLE** is a constant with value 10):

```
        0  " My Menu "  EXAMPLE  NEW.MENU
```

Menu Insertion Point

This is the menu id that the newly defined menu is to be inserted **before** in the menu list. Specifying the menu insertion point of 0 is a special case; it means that you want the menu to be inserted at the **end** of the menu bar.

Menu ID

The menu id is any number from 1 to 31 that you choose to refer to your new menu as. We recommend that you use a CONSTANT for your menu ids for later reference to the menu (like we did with **EXAMPLE**). You can choose any number you like, but we recommend that you use numbers greater than 10 in order to avoid possible conflicts with system menus. In case of a conflict, the system will use the first menu it finds with the menu id given.

Menu Title

The title you choose for your menu is a string of up to approximately 80 characters (as long as it fits on the screen). You should use concise, meaningful names for your menu titles.

Menu Items

Each of the available selections in a menu is referred to as a "menu item." The items in "My Menu" ("Item 1","Item 2" and "Item 3") were appended to "My Menu" with the word **APPEND.ITEMS** used in the following form:

```
   <"item list"> <menu id>  APPEND.ITEMS
```

In our example, the phrase

```
    " Item 1<B<U;Item 2/2;Item 3<I("   EXAMPLE  APPEND.ITEMS
```

passed the item list (the quoted string) to **APPEND.ITEMS** for menu id 10 (using the constant **EXAMPLE**).

Item List

The item list from our example may seem strange at first, but take a closer look. You can see the menu items listed ("Item 1", 2 and 3), which contain some special character suffixes. The following are special characters used as suffixes and cannot be specified as part of an item in the item list:

Special Character	Meaning
;	Separates items in the list (eg. " Item 1;Item 2;item 3").
<	highlights the preceding item according to the character following <. The available highlight characters are: B for **Bold** (letters must be uppercase); I for *Italic*; O for Outline; S for Shadow; U for Underline (eg. " Item 1<B<U;Item 2<O;")
(	Disables the preceding item, displaying it in light gray. The item cannot be selected until it is enabled. (eg. " Function 1; Function 2(; Function 3(;")
/	Assigns the key immediately following the / as the ⌘ key sequence for that menu item. (eg. " Attack/A;Retreat/R;")
!	Precedes the item with the character immediately following the ! (eg. " Fire!*;")

Now, using the above table, let's go back and look at the item string again. The first item:

Item 1<B<U;

specified the string "Item 1" as the menu item and made it bold faced, underlined. The second item:

Item 2/2

specified the string "Item 2" as the menu item and assigned the ⌘2 key to it. When the ⌘2 key is pressed , Item 2 will be executed. The third item:

Item 3<I(

specified the string "Item 3" as the menu item and italicized it. The "(" disabled the item, preventing the operator from accessing it.

Special Strings You can display the Apple logo (apple with a bite), a check mark, any of the special characters, or any of the displayable characters on the Mac by creating a string and modifying it directly. For example, the Apple logo is character 20 (decimal) (a check mark is decimal 18). Try finding that key on the keyboard! (You can't, it doesn't exist.) To create a string with the apple in it you could execute:

```
      CREATE APPLE$  1 C, ( for the count )  20 C,  ( logo character )
```

You could then use **APPLE$** in your menu defintion in place of the quoted string:

```
      APPLE$  EXAMPLE  APPEND.ITEMS
```

Separating Menu Items You can separate items in a menu with a horizontal bar by using a "-" character and disabling it as an item. For example, the string

```
    " Item 1;-(;Item 2"   <menu #>  APPEND.ITEMS
```

passed to **APPEND.ITEMS** would separate Item 1 and Item 2 with a line. Note that the line is considered an item in the list when a menu item is selected. This means that in the above item list, "Item 1" would be item #1, the line would be item #2, and "Item 2" would be item #3.

Displaying the Menu

DRAW.MENU.BAR displays the new menu bar. Your menu is now active and ready to be used just like any other menu. If you are adding several menus, use **DRAW.MENU.BAR** after you have created and inserted the menus in the menu list to avoid having the menu bar flash each time a menu is added.

Menu Item Selection

The word **MENU.SELECTION:** determines what action is taken when an item is selected in your new menu and is used in the form:

```
     <menu id>  MENU.SELECTION:  <action to take>
```

Where the menu id is the id you assigned to the menu. When an item is selected, the item number of the selection is passed to the code following **MENU.SELECTION:** for execution of the appropriate action.

<u>Menu Item Numbers</u> Each menu item is assigned a number when it is appended to the menu. The numbers start at 1 and are incremented by one for each item. For clarity, in our example, we numbered the items according to their item number. This means that our "Item 1" selection is actually item number 1, "Item 2" is item number 2 and so on. When an item selection occurs, this is the number which determines the action to take.

<u>Menu Item Execution</u> When a menu item is selected, the code immediately following **MENU.SELECTION:** for that menu is executed with the item number on the stack. The code executed is usually a case statement which tests the value on the stack and executes the appropriate code.

To make this more clear, let's examine what happened when you clicked Item 1 in "My Menu." The system saw a mouse click on menu item one and passed control to the **MENU.SELECTION:** code for menu 10 (which was defined with the **EXAMPLE MENU.SELECTION:** ... phrase). The code for menu 10's menu selection is the following case statement:

```
      CASE  1  OF  CR  ." Item 1 Selected!"  ENDOF
            2  OF  CR  ." Item 2 Selected!"  ENDOF
            3  OF  CR  ." Item 3 Selected!"  ENDOF
      ENDCASE    0 HILITE.MENU
```

which executed case 1 of the statement and returned to what you were doing before the mouse click occurred. The items in a menu are executed transparently, returning immediately to what was executing before the selection occurred.

Menu Highlighting

The word **HILITE.MENU** serves two purposes: (1) to highlight a menu, and (2) to unhighlight all others. **HILITE.MENU** highlights (inverts the title of) the menu whose menu id is on the stack. For example, to highlight the "Options" menu (its menu id is 3), execute

```
      3 HILITE.MENU
```

To un-highlight it, execute

```
      0 HILITE.MENU
```

Since there is no menu with id 0, all the menus were unhighlighted when the above command was executed.

After selection of a menu item, the menu title remains highlighted. This allows you to indicate to the operator that the selected item is still executing. You need to unhighlight the menu under program control. That is why we execute

```
      0 HILITE.MENU
```

after the case statement in our example menu.

Modifying Menu Execution You can modify the function of a menu by simply re-defining the menu selection definition. Try the following to change the execution of our example menu:

```
     :  NEW.EXAMPLE.FUNCTION  ( --- )
            EXAMPLE   MENU.SELECTION:
          CASE   1  OF  CR  ." New Function 1"  ENDOF
                 2  OF  CR  ." New Function 2"  ENDOF
                 3  OF  CR  ." New Function 3"  ENDOF
          ENDCASE  0 HILITE.MENU ;

     NEW.EXAMPLE.FUNCTION
```

Now try the items in "My Menu" and you'll see the new functions executed when you make your selections. This powerful feature allows you to change the function of any menu at any time.

Modifying Menu Items

You can modify the menu items (type style, enable/disable, add/delete check marks or characters, etc.) with the following functions (each function takes item* and menu id, where the item* is the item number in the menu; menu id is the number of the menu):

ITEM.STYLE allows you to change the style of the item. Used in the form:

```
      <item*> <style> <menu id> ITEM.STYLE
```

where <style> is one or a combination of the following styles:

Style	Value
PLAIN	0
BOLD	1
ITALIC	2
UNDERLINE	4
SHADOW	8
OUTLINE	16

To get multiple styles, add the values together. For example, to get underlined shadow as the style, you would execute:

```
         <item*> UNDERLINE SHADOW +   <menu*>   ITEM.STYLE
```

ITEM.MARK allows you to attach to or remove a character from an item. Used in the form:

```
      <item*>  <mark>  <menu id>  ITEM.MARK
```

where <mark> is the character to append to the item. If <mark> is zero, any character currently appended is removed. <mark> is any valid ASCII character or special Mac character (ie: 20 is the Apple logo).

ITEM.CHECK allows you to append to or remove a check mark from a menu item based on a flag value. Used in the form:

```
      <item*>  <flag>  <menu id>  ITEM.CHECK
```

where <flag> is a boolean flag. If <flag> is -1 , a check mark is appended to the item, if <flag> is 0, the check mark is removed.

ITEM.ENABLE allows you to enable or disable any item in the menu. Used in the form:

```
      <item*>  <flag>  <menu id>  ITEM.ENABLE
```

where <flag> is a boolean flag. If <flag> is -1, the item is enabled, if <flag> is 0, the item is disabled.

SET.ITEM$ allows you to change the string associated with any menu item.

```
      <Item*> <string addr> <Menu*> SET.ITEM$
```

Deleting a Menu

You can delete a menu from the menu list by executing the word **DELETE.MENU** . Given a menu number on the stack, **DELETE.MENU** deletes the menu from the menu list and re-draws the menu bar, removing the menu.

```
      <menu #>  DELETE.MENU
```

It is a good idea to execute **DELETE.MENU** for the menu number you are about to add (with **NEW.MENU**). This ensures that you won't inadvertently add the menu twice and is a good way to insure against multiple menus with the same number.

The apple menu (the solid apple with a bite taken out of it) has menu id 1; the Options menu has menu id 3. You can delete either or both of these menus using **DELETE.MENU**. To re-install them, execute **APPLE.MENU** or **OPTIONS.MENU** for the apple and Options menus respectively.

Disabling a Menu

You can enable/disable a menu at any time using the command **MENU.ENABLE** in the following form:

```
      <flag>  <menu id>  MENU.ENABLE
```

where <flag> is a boolean flag. If <flag> is true, the menu is enabled, if <flag> is false, the menu is disabled.

Appendix A: Example Menu

The following menu example is provided for you to use as a template for your menus. It creates a menu that is similar to the MacFORTH Options menu.

```
13 CONSTANT OP.MENU
:  OPTIONS.MENU  ( -- )
    0  " OPTIONS "  OP.MENU  NEW.MENU
    " TRACE/T;DEBUG/D;WORDS;ABORT/A"  OP.MENU  APPEND.ITEMS
    DRAW.MENU.BAR  OP.MENU  MENU.SELECTION:  0  HILITE.MENU
    CASE
      1  OF  TRACE  @  NOT  DUP  TRACE  !  1  SWAP  OP.MENU
               ITEM.CHECK  ENDOF
      2  OF  DEBUG  @  NOT  DUP  DEBUG  !  2  SWAP  OP.MENU
               ITEM.CHECK  ENDOF
      3  OF  WORDS  ENDOF
      4  OF  1  ERROR"  ABORTED!!"  ENDOF
   ENDCASE  ;
```

Chapter 8: Windows/Events

Overview

This chapter discusses window and event management using MacFORTH. By now you should have completed both the Getting Started and Getting Results chapters which introduce and give examples of windows and event handling. The intent of this chapter is to provide you with an in-depth reference guide to windows and events.

The concept of windows and event handling is very important in the Macintosh environment and MacFORTH allows you to control virtually every aspect of a these features (or leave it to the default handlers).

MacFORTH does all the hard work relating to using windows and events in a fashion compatible with the Macintosh user interface. Default event handlers provide for what you should expect to happen when a particular event occurs. You can, of course, override the default operations to handle special cases.

Defining a Window

The command **NEW.WINDOW** creates and defines a new window structure for MacFORTH. To create a new window, simply execute **NEW.WINDOW** followed by the name you want to call the new window. For example:

```
      NEW.WINDOW  MY.WINDOW
```

creates a new window named **MY.WINDOW** with the standard MacFORTH defaults. These defaults are:

a.) title = "Untitled Window"
b.) bounds = (100,100) (200,300)
c.) no close box or size box
d.) the action of the window is to beep when an event occurs

NEW.WINDOW can only be executed; you cannot use it inside a colon definition.

Window Components

A window is made up of one or more of the following components:

Window Title

The title assigned to a document window is displayed in the title bar across the top of the window. You can choose any title you like for a window and assign it using the **W.TITLE** command during the definition of the window in the following format:

```
      " <title string>"  <window pointer>   W.TITLE
```

For example, to assign the title "My Very Own Window" to a window named **MY.WINDOW**, you would execute

```
      " My Very Own Window"  MY.WINDOW  W.TITLE
```

You can also re-assign a title to a window with the **SET.WTITLE** command used in the following format:

```
      " <title string>"  <window pointer>  SET.WTITLE
```

When **SET.WTITLE** is executed, the title bar of the window is immediately redrawn with the new title.

Window Bounds

To set the initial position and size of a window, use the **W.BOUNDS** command when the window is defined. Use the following format:

```
      <top>  <left>  <bottom>  <right>   <window pointer>  W.BOUNDS
```

The <top> <left> <bottom> and <right> values are the coordinates of the rectangle for the window, relative to the upper left corner of the screen. For example:

```
      100  150   300  350   MY.WINDOW  W.BOUNDS
```

will set the upper left corner of **MY.WINDOW** (used for example only) to be 100 dots from the top of the screen, 150 dots from the left side of the screen. The lower right corner of the window is 300 dots from the top of the screen, 350 dots from the left of the screen.

Window Attributes

When a window is defined, you can set the attributes for it with the **W.ATTRIBUTES** command. The attributes for a window are:

a.) CLOSE.BOX	gives the window a close box
b.) NOT.VISIBLE	makes the window invisible
c.) SIZE.BOX	gives the window a size box
d.) SCROLL.UP/DOWN	gives the window a vertical scroll bar
e.) SCROLL.LEFT/RIGHT	gives the window a horizontal scroll bar

To set the attributes for a window when defining it, select the attributes you want the window to have and add them before executing **W.ATTRIBUTES**. For example, to give the window **MY.WINDOW** a close box and size box, you would execute:

```
      CLOSE.BOX  SIZE.BOX  +   MY.WINDOW  W.ATTRIBUTES
```

when you define the window.

Window Types

Another attribute of a window is the window type. The default window type is the one you are the most familiar with, a document window (a rectangle with a title bar/drag region). There are three other types:

Type 1 is a simple frame. A thick rectangle outlined by a thin rectangle. Try the following example:

```
      NEW.WINDOW  WIN1
         1 WIN1 W.TYPE
      WIN1 ADD.WINDOW
```

Click back in the MacFORTH window to continue.

Type 2 is a thin rectangle. Try the following example:

```
      NEW.WINDOW  WIN2
         2 WIN2 W.TYPE
      WIN2 ADD.WINDOW
```

Click back in the MacFORTH window to continue.

Type 3 is a shadowed rectangle (like an alert box). Try the following example:

```
      NEW.WINDOW  WIN3
         3 WIN1 W.TYPE
      WIN3 ADD.WINDOW
```

Click back in the MacFORTH window to continue.

Window Program

Use **ON.ACTIVATE** to define the function of a window. **ON.ACTIVATE** specifies the word to be executed when a window is activated. The default for this function is
a word which will just beep when any event occurs within a window. Use **ON.ACTIVATE** in the following form:

```
      <window name>  ON.ACTIVATE  <word to execute>
```

For example, to assign the word **MY.PROGRAM** to a window named **MY.WINDOW**, you would execute

```
      MY.WINDOW  ON.ACTIVATE  MY.PROGRAM
```

As we discussed in the Getting Results chapter, when a window is activated, the word specified by **ON.ACTIVATE** for the window is passed a flag. This flag is true (-1) if the window was activated and false (0) if another window is activated (hence the current window is deactivated). This allows you to start up your program when the window is activated and perform any cleanup when the window is deactivated. It is important to check this flag as the first thing when you execute your program. Any programs you assign to a window should follow a template similar to:

```
      :  WINDOW.PROGRAM    (  activate flag -- )
           IF    ( code for activate  )
           ELSE  ( code for deactivate )
           THEN   ;
```

If you **FORGET** the word which defines the function of a window, and attempt to select the window without redefining it, you will get unpredictable results when the window is activated. If you don't specify a word following **ON.ACTIVATE** (i.e. you just press return) you will get the error message "ATTEMPTED TO REDEFINE NULL!".

Closing a Window

When a window is closed by a click in its close box, MacFORTH automatically hides the window from view and returns an **IN.CLOSE.BOX** event from **DO.EVENTS**. You don't need to be concerned with hiding the window, as it has already been hidden before you are notified that the close box has been clicked. This lets you perform any cleanup that should occur when a window is closed. Since the window is hidden, the next occurence of **DO.EVENTS** will select the window closest to the front of the display.

Sizing a Window

When a window is resized by dragging its size box, MacFORTH will automatically handle the resizing for you and return an **IN.SIZE.BOX** event from **DO.EVENTS**. You don't need to be concerned with actually resizing the window, as it has already been resized before you are notified of the event.

Event Handling in a Window

The Macintosh is an event driven computer. This means that your programs should be aware of the events occurring when they are executing. The word **DO.EVENTS** handles this automatically for you, performing any default actions (resizing a window, hiding it when a close box is clicked, accepting keystrokes, etc.) and notifying you that the event occured. If you ignore events as they occur, your program may not be consistent with the Macintosh environment. To maintain consistency, your programs should be running an endless loop that checks for the occurence of events by executing **DO.EVENTS**.

With this in mind, you should expand the above template to be:

```
:  WINDOW.PROGRAM    ( activate flag -- )
   IF    BEGIN   DO.EVENTS
               ( code for activate which checks the events )
         AGAIN
   ELSE  ( code for deactivate )
   THEN   ;
```

The code for activation should check the code returned by **DO.EVENTS** against a list of any events you care about.

The following MacFORTH constants contain the event codes for the most used events that occur (refer to the end of this chapter for a complete listing of event codes):

MacFORTH Constant	Event
MOUSE.DOWN	mouse button pressed
IN.CLOSE.BOX	mouse click inside the close box
IN.SIZE.BOX	mouse click inside the size box

The Mouse Interface

An important feature of the Macintosh user interface is the mouse. It provides a highly flexible, easy to use method of input/choice selection. The current mouse position and state of the button (up or down) are automatically monitored by the Macintosh operating system. System related functions (like menu selection; activation of another window; closing, resizing, and dragging a window) are handled automatically for you -- you are notified of the event after the default action has been taken.

We have broken down our discussion of the mouse interface into two areas: dynamic mouse operations and event related mouse operations.

Dynamic Mouse Operations

Dynamic mouse operations provide a real-time glimpse of the position of the mouse and/or the state of the mouse button (up or down).

Dynamic Mouse Position in User Coordinates

@MOUSEXY returns the current position of the mouse in "user coordinates". User coordinates refer to a point relative to the currently active window, taking into account the values of **XYPIVOT**, **XYSCALE**, and **XYOFFSET**. Here's a definition to display the current mouse position:

```
      : ?MOUSE    ( --- | display the current mouse position )
          BEGIN  13 EMIT  @MOUSEXY   SWAP . .   AGAIN  ;
```

(Since this is an endless loop, you'll need to select Abort from the Options menu -- or ⌘A to stop output.) Now try:

```
      GINIT    SRCCOPY TEXTMODE  ( to overwrite the old )
      ?MOUSE
```

You can now see the position of the mouse in QuickDraw coordinates being displayed continuously. Move the mouse around now. If you move it up, you can see the y-axis value decrease, if you move it to the right, you can see the x-axis value increase. Abort by selecting Abort from the Options menu.

Try the following to display the mouse coordinates in Cartesian coordinates:

```
      CARTESIAN ON  PAGE
      CENTER  XYAXIS
      ?MOUSE
```

Now move the mouse around. You can see that the mouse position is reported to you in Cartesian coordinates now; if you move the mouse up, the y-axis value increases.

A word like **?MOUSE** is helpful for digitizing the points of a graphics image you have (or would like to) produce. It's also a good learning tool for showing the difference between Cartesian and QuickDraw coordinates.

Remember to abort **?MOUSE** before continuing (by either pressing ⌘A or selecting Abort from the Options menu).

Dynamic Mouse Position in Screen Coordinates

Most Macintosh toolbox operators that deal with the position of the mouse expect to deal with a "point" relative to the current window in local coordinates.

A "point" is simply two 16-bit values (x and y) packed into one 32-bit long word (one item on the stack). The y coordinate is in the high-order 16-bits of the long word, the x coordinate is in the low-order 16-bits. We have provided two operators to simplify working with "point" values: **POINT>XY** and **XY>POINT**. **POINT>XY** converts the point on the stack to its x and y coordinate values. **XY>POINT** converts the x and y coordinate values on the stack to a point.

Coordinates for the mouse are expressed in two basic forms: local and global. Local coordinates use the upper left corner of the content (under the drag region) region of the current window as the origin (0,0) in QuickDraw coordinates. Global coordinates use the upper left corner of the screen as the origin (0,0) in QuickDraw coordinates.

The word **@MOUSE** returns the current point of the mouse in local coordinates. Try:

```
      @MOUSE  DUP .
      POINT>XY SWAP . .  ( need to SWAP to display it as x,y )
```

Here's a word to try using **@MOUSE** and **POINT>XY**:

```
      : SCAN.MOUSE  ( --- )
          BEGIN  13 EMIT  @MOUSE  POINT>XY  SWAP . .   AGAIN  ;
```

Now execute

```
      GINIT   PAGE
      XYAXIS ( the xy-axis is drawn in the upper left corner)
      SCAN.MOUSE
```

Move the mouse around. Notice that as you go up, as you would expect in QuickDraw coordinates, the y-axis value decreases. If you move up above the content region of the window, the y-axis value goes negative. Abort **SCAN.MOUSE** and continue.

Point in Rectangle Computation

Frequently it is necessary to determine if a point is within the bounds of a given rectangle. This is useful for controlling the cursor (as in the editor, where we use an i-beam if the mouse is in the content region of the window, otherwise an arrow cursor), determining the selection made by an operator, or just following the mouse. Used in the form:

```
      <point>  <rect>  PTINRECT
```

PTINRECT (for "point in rect") checks a given point to see if it is within the bounds of a specified rectangle. A true flag is returned if the point is within the rectangle, otherwise a false flag is returned. Edit the following example into a blank block:

```
      ( Mouse Tracking Example )

      10 30  50 100  RECT BOX

      : FOLLOW.MOUSE  ( --- )
          PAGE  GINIT  XYAXIS  BOX @RECT XY><TLBR  FRAME RECTANGLE
           BEGIN  150 150 MOVE.TO
                 @MOUSE BOX PTINRECT
                    IF    ." Mouse in Box!!"
                    ELSE  ." Mouse Not in Box!!"
                    THEN
           AGAIN  ;
```

Load the block and execute **FOLLOW.MOUSE**. Move the mouse around inside and outside the framed rectangle and watch the message change.

Here are a few more examples of tracking the mouse. Edit them into blank blocks, load them and try each one:

```
      ( Game Board Template Example )

      100 150  200 250  RECT  GAME.BOARD

      : GAME  ( --- | simulate changing of the cursor on a game board )
              ( ** this is the method used in the editor **           )
              ( press any key to end the loop )
          GINIT  PAGE   GAME.BOARD @RECT XY><TLBR FRAME RECTANGLE
           BEGIN  @MOUSE  GAME.BOARD  PTINRECT
                    IF   IBEAM SET.CURSOR   ELSE  INIT.CURSOR  THEN
                  ?TERMINAL
           UNTIL  ;


      ( Hide Cursor Example )

      : HIDDEN.CURSOR  ( --- | hide the cursor if the mouse moves )
                       ( outside the content region of the window )
                       ( End the loop by pressing any key.  Also, )
                       ( try resizing the window and watch the cursor)
          BEGIN  @MOUSE  LOCAL>GLOBAL  FIND.WINDOW   3 =
                 SWAP  SYS.WINDOW =  AND
                  IF   ( in content region of SYS.WINDOW )
                       INIT.CURSOR
                  ELSE HIDE.CURSOR
                  THEN ?TERMINAL
          UNTIL  INIT.CURSOR   ;
```

Dynamic Mouse Button Monitoring

You can read the current state of the mouse button with **MOUSE.BUTTON**. **MOUSE.BUTTON** returns a true flag if the mouse button is down, a false flag if the mouse button is up.

Event Related Mouse Operations

When **DO.EVENTS** is executed, MacFORTH places the next event from the event queue into the **EVENT.RECORD** array. Mouse down events copy the event record to the mouse down record, mouse up events copy the event record to the mouse up record. Event related mouse operations operate on the contents of either the mouse up or mouse down records following notification by **DO.EVENTS** that a mouse related event has occurred. Refer to the Event Masking section of this manual for how to mask mouse related events.

Format of the Mouse Down Record

The following table describes the contents of the mouse down record:

Offset	Length	Description
0	4	event code (1)
4	4	message (relevant wptr set by MacFORTH)
8	4	when (in ticks)
12	4	where (point in global coordinates)
16	2	modifiers (special key state)

The modifier bits are:

Bit#	Mask (hex)	Meaning
7	80	mouse button down
8	100	⌘ key down
9	200	Shift key down
10	400	Caps Lock key down
11	800	Option key down

MacFORTH provides two operators that access the mouse down record "where" field: **MOUSE.WAS..** returns the point in global coordinates, **@MOUSE.DN** returns the point in local coordinates. Each operator returns the point where the mouse button was last pressed.

Event Related Mouse Button Operators

When executed after a mouse down event, **STILL.DOWN** tests to see if the mouse button is still down. It returns a true flag if the button is down <u>and</u> there are nor more mouse events in the event queue. This is a true test if the button is still down from the original press (unlike **MOUSE.BUTTON** which simply gives you the <u>current</u> state of the mouse button).

WAIT.MOUSE.UP works just like **STILL.DOWN**, except that if the mouse button is not still down from the original press, **WAIT.MOUSE.UP** removes the corresponding mouse up event before returning a zero flag.

Detecting Double Clicks

To determine if a double click has occurred, use the word **?DOUBLE.CLICK**. **?DOUBLE.CLICK** returns a true flag if a double click has occurred. Try the following example:

```
      : DOUBLE.TEST  ( --- | test for clicks until a key is pressed )
          BEGIN  DO.EVENTS  MOUSE.DOWN =
                  IF  ?DOUBLE.CLICK
                       IF  ." Double"   ELSE ." Single"  THEN
                     ."  Click"  CR
                  THEN  ?KEYSTROKE
          UNTIL  DROP  ;
```

Example

In order to further illustrate tracking the mouse, closing a window, and sizing a window, try the following example (edit it into 2 blank blocks on disc):

```
      ( Finger Paint Window Example )
      NEW.WINDOW  SHEET
           " Finger Paint Window"  SHEET  W.TITLE
           40 40  200 200          SHEET  W.BOUNDS
           CLOSE.BOX  SIZE.BOX +   SHEET  W.ATTRIBUTES

      SHEET  ADD.WINDOW

      : TRACE.FINGER  ( --- )
           HIDE.CURSOR
            BEGIN   STILL.DOWN   WHILE  @MOUSEXY  DOT  REPEAT
           SHOW.CURSOR   ;

      ( Finger Paint Example Continued )
      : FINGER.PAINT  ( activate flag -- )
           IF    BEGIN   DO.EVENTS
                 CASE    MOUSE.DOWN    OF  TRACE.FINGER        ENDOF
                         IN.SIZE.BOX   OF  ." Window Resized!" ENDOF
                         IN.CLOSE.BOX  OF  7 SYSBEEP           ENDOF
                 ENDCASE
                      AGAIN
           ELSE ." Window Deactivated"
           THEN  ;

      SHEET  ON.ACTIVATE  FINGER.PAINT
```

Handling Keystrokes

If you want to input data from the keyboard in another window, you should look for keystrokes in the activate portion of your program. Input of keystrokes are handled differently from other events in that you can check for the presence of a keystroke (if one has been pressed) and get the key at any time in the activate loop part of the program.

The word **?KEYSTROKE** checks for a keystroke (returned by **DO.EVENTS**) and returns either a false flag indicating no keystroke was pressed, or a key value under a true flag if a key was pressed.

Here's an example which modifies the finger painting example to include check for input of an "S" key for skinny mode, "M" key for medium mode, or "F" for fat mode:

```
  :  DO.FINGER.KEY   (  key value  -- )
       CASE  83  ( "S" )  OF  1  1   PENSIZE    ENDOF
             77  ( "M" )  OF  3  3   PENSIZE    ENDOF
             70  ( "F" )  OF  5  5   PENSIZE    ENDOF
            7  SYSBEEP
       ENDCASE  ;
```

Now modify **FINGER.PAINT** to be:

```
  :  FINGER.PAINT  ( activate flag  -- )
       IF     BEGIN   DO.EVENTS
             CASE    MOUSE.DOWN  OF   TRACE.FINGER   ENDOF
                   ?KEYSTROKE   IF   DO.FINGER.KEY   THEN
             ENDCASE
                  AGAIN
       ELSE  7 SYSBEEP   ." Finger Painting Finished"
       THEN  ;

  SHEET  ON.ACTIVATE  FINGER.PAINT
```

Now when you activate the Finger Paint window, you can change the pen size by pressing the S, M or F key.

Another use of **?KEYSTROKE** is to trap any non-⌘ keys (remember **KEY** traps Return, Enter, Tab and Backspace). Here's a word which will trap any non-⌘ keys:

```
  : ALL.KEY  ( -- key# )
     BEGIN  DO.EVENTS  DROP  ?KEYSTROKE  UNTIL  ;
```

Now execute **ALL.KEY** and press Return (value 13), or Enter (value 3), or Tab (value 9), or Backspace (value 8).

Default Event Actions

MacFORTH executes a default operation for each event, within **DO.EVENTS**, prior to returning an event code to the user. The default operation typically handles all of the messy details required by the Mac User Interface and just returns an event code to let you know what happened. The default actions are summarized below for each event.

Common to all events: If a keystroke has been received but not picked up by the user (via **KEY**) no further keystroke events are allowed until the current one is cleared. Type-ahead characters are thus accumulated in the event queue. If a mouse down event occurs outside the content region of the current window, events 17-24 are systhesized to indicate a special mouse down event.The following events have special default actions:

MacFORTH Event Constant	Default Action
MOUSE.DOWN	Checks for events 17-23 and if appropriate returns that code instead. A code of 1 indicates a mouse down in the content region of the current window and the event record is copied to the mouse down record.
MOUSE.UP	The event record is copied to the mouse up record.
KEY.DOWN	The event record is copied to the keystroke array.
UPDATE.EVENT	Begins update, passes control to the window update token, and ends the update event.
WINDOW	Passes control to the window's activate token.
COMMAND.KEY	Simulates a menu event.
IN.DESKTOP	Beeps.
IN.SYS.WINDOW	Passes control to the execution procedure posted for the menu by **MENU.SELECTION:**.
IN.LOWER.WINDOW	Activates the lower window.
IN.DRAG.BOX	Drags the window.
IN.SIZE.BOX	Resizes the window.
IN.CLOSE.BOX	Hides the window.

Complete Events List

DO.EVENTS always returns one of the following event codes:

Code	Event	Code	Event
0	NULL.EVENT	10	NETWORK.EVENT
1	MOUSE.DOWN	11	DRVR.EVENT
2	MOUSE.UP	16	COMMAND.KEY
3	KEY.DOWN	17	IN.DESKTOP
4	KEY.UP	18	IN.MENU.BAR
5	AUTO.KEY	19	IN.SYS.WINDOW
6	UPDATE.EVENT	20	IN.LOWER.WINDOW
7	DISK.EVENT	21	IN.DRAG.BOX
8	ACTIVATE.EVENT	22	IN.SIZE.BOX
9	ABORT.EVENT	23	IN.CLOSE.BOX

Note: Refer to "Inside Macintosh" documentation from Apple for the meaning of events not described in this chapter.

Event Masking

MacFORTH maintains an event mask in the variable **EVENTS**. This mask is used by **DO.EVENTS** to retrieve the next available event from the event queue. The bit number within the mask corresponds to the event number. You can convert an event code to a mask bit by executing:

```
      <event code> 1 SWAP SCALE
```

Since we use this quite frequently in the upcoming examples, here's a word to do the conversion:

```
      : EVENT.BIT  ( event code -- bit # )   1 SWAP SCALE  ;
```

If a keystroke is waiting in the keystroke array (indicated by

```
      KEYSTROKE @
```

returning a true flag), **DO.EVENTS** masks the contents of **EVENTS** with the result of

```
      AUTO.KEY EVENT.BIT  KEY.DOWN  OR
      KEY.UP OR  -1  XOR
```

to avoid keyboard events overwriting each other. If you don't care, execute

```
      KEYSTROKE OFF
```

prior to executing **DO.EVENTS**.

Event Precedence

The Macintosh toolbox only supports 16 of MacFORTH's 24 event types. When a keystroke or mouse down event occurs, MacFORTH automatically synthesizes one of the other event types if appropriate.

Event (Code)	Synthesized Event (Code)
KEY.DOWN (3)	COMMAND.KEY (16)
MOUSE.DOWN (1)	IN.MENU.BAR (18)
	IN.SYS.WINDOW (19)
	IN.LOWER.WINDOW (20)
	IN.DRAGBOX (21)
	IN.SIZE.BOX (22)
	IN.CLOSE.BOX (23)

In order to enable an event produced by **KEY.DOWN** or **MOUSE.DOWN**, you need to enable the respective producing event. For example, if you choose to disable all events, you would execute:

```
      EVENTS OFF
```

To re-enable all events, execute

```
      EVENTS ON
```

The MacFORTH text interpreter automatically executes

```
      EVENTS ON
```

to avoid the problem of having all events disabled (which would hang the computer).

To enable only one event, for example, a mouse down in the menu bar, you would execute:

```
      : MENUS.ONLY  ( --- | allow only mouse downs in menu bars )
          MOUSE.DOWN  EVENT.BIT
          IN.MENUBAR  EVENT.BIT  OR   EVENTS !  ;

      : MENUS.ONLY.EXAMPLE  ( --- )
          MENUS.ONLY
           BEGIN  DO.EVENTS DROP AGAIN
          EVENTS ON  ( re-set the events )  ;
```

Events During Text Input or Output

MacFORTH executes **DO.EVENTS** after every string is output, as well as every time **?TERMINAL** is executed (as in **KEY**). When an event occurs during text I/O, its default action is taken, and the event record is removed from the queue. Two strategies are available for handling events during text I/O: masking and event detection.

Event Masking During Text I/O

Masking simply ignores any specified events which you don't want discarded by **DO.EVENTS**. The simplest case is:

```
      EVENTS @  EVENTS OFF
      ." Now is the time "
      EVENTS !
```

In the above example, we politely restored the event mask the way that we found it. You can also selectively enable or disable events with a mask.

Event Detection During Text I/O

You can also set a flag which will change if an event is serviced. The contents of the first four bytes of the following event data structures will be modified if an event occurs:

```
      KEY.STROKE          KEY.UP.RECORD
      MOUSE.DOWN.RECORD  MOUSE.UP.RECORD
```

For example:

```
      : EVENT.TEST  ( --- )
          MOUSE.DOWN.RECORD OFF
           BEGIN  CR ." Text Output"  MOUSE.DOWN.RECORD @  UNTIL  ;
```

Note that the mouse down event has, by default, setup for **MOUSE.WAS..** and **@MOUSE.DOWN**.

Chapter 9: File System

Overview

This chapter discusses how MacFORTH interfaces to the Macintosh file system. Using MacFORTH, you can create, read and write any standard Macintosh file. This allows you to share data among applications.

You can have up to 9 files assigned and open at a time for accessing the data within a file. MacFORTH supports two file types: data and program (or "blocks") files. The records within a data file can be one of three types: fixed length records, text records and virtual data files (free-format records). The records within a program file are fixed length records, each containing 1024 characters.

We refer to program files as "blocks" files because they are made up of source code blocks (as explained in the Editor chapter).

File Input/Output Operation Result Codes

For each file operation a result code is returned in the variable **IO-RESULT**. This result code allows you to check the operation to see if it completed successfully, and if not, why not.

Each of the I/O result codes are listed in Appendix B of this chapter for your reference. If the file operation is successful, the result code is 0, otherwise the value indicates an error condition. This allows you to monitor the result of each file operation. You can then set the level of error checking from no checking to full error checking/re-try attempts, etc. If you aren't concerned with the result of the operation, ignore it.

The word **?FILE.ERROR** is provided to handle most file operation error conditions. You should execute **?FILE.ERROR** immediately following a file operation and, if an error occurred, it will abort the current task displaying the appropriate error message. For example if you executed the phrase (<u>don't</u> try it now):

```
          OPEN" My File"  ?FILE.ERROR
```

and the file named "My File" was not found (I/O result code -43), the current task would be aborted and the error message "File Not Found!" would be displayed.

File Assignment

The Macintosh file system is based on assigning files (using their names) to a file number and using that number in referring to the file. In MacFORTH, we recommend that you use a CONSTANT value to refer to the file number to make your programs more readable.

File Numbers

MacFORTH allows you to access up to 9 files using file numbers 0-8. If you use a file number outside of the range 0-8, MacFORTH will issue the error message "Illegal File#". The "file number" is just an index into a table of file control blocks (FCBs) which contain information about each file. When we refer to an FCB we mean the address of the FCB for the specified file. When we refer to a file number, we mean the index of the FCB.

You don't need to be concerned with what the actual file number is for a given file, as MacFORTH can automatically assign it to the next available FCB for you. If you want to know the index of the next available FCB, the word **NEXT.FCB** will leave it on the stack. The error message "No FCBs Available!" indicates all of the FCBs are in use. (We'll discuss the **REMOVE** command later in this chapter which is used to free up an FCB).

Displaying File Assignments

You can display the current file assignments by executing the **?FILES** command. Each file number is displayed with its associated file name. A capitalized "O" next to the number implies the file is open. A lowercase "b" indicates it is a blocks file, a capitalized "B" next to a file number indicates it is the current blocks file.

Opening a File

If a file already exists on disc, you can open it with the **OPEN"** command in the following format:

```
          OPEN" <file name>"
```

OPEN" will attempt to open the file named <file name>. If successful, the FCB index is left on the stack so you can reference the file. If there is an error during the attempt to open the file, an appropriate error message is displayed, and the system aborts execution. For example, here's a phrase which will try to open the file named "Salary File", and create a constant named **SALARY.FILE** if the file is opened correctly:

```
          OPEN" Salary File"  CONSTANT SALARY.FILE
```

You can reference the file using the constant **SALARY.FILE**. If you aren't concerned with the file number, you can just **DROP** it from the stack after opening the file.

OPEN" is similar in function to **USE"**, except that it will open any type of file (blocks and non-blocks files), it returns the file number, and does not select the opened file.

<u>Alternate Volumes</u>
You can access files on another (previously mounted) volume by simply using the volume name as a prefix to the file name in the **OPEN"** statement. For example, to open the file named "Employee Salary" on the volume named "Employee Information", you would execute:

```
OPEN" Employee Information:Employee Salary"
  CONSTANT SALARY.FILE
```

When you access the file later, you will be prompted to insert the "Employee Information" disk if it is not in the drive.

Displaying the Disk Directory

The **DIR** command displays the contents of the disk directory of the disc in the specified drive. To display the directory of the disk in the internal drive, execute: `INTERNAL DIR`

To display the directory of the disk in the external drive (if present), execute:

```
EXTERNAL DIR
```

The following information is presented when you use the **DIR** command:

1.) volume name
2.) number of files
3.) amount of space available
4.) volume creation date
5.) volume last modified date
6.) for each file:
    a.) file name (first 19 characters)
    b.) file attributes
        i.) "L" for locked, "-" for unlocked
        ii.) "U" for in use, "-" for not in use
    c.) file type
    d.) file size
    e.) file creation date
    f.) file last modified date

MacFORTH File Types

There are two standard types of files you will use with MacFORTH: data files and blocks files. Data files contain data in a free-format. Blocks files contain program source code in sequential fixed length records.

From the Finder, you can distinguish between these two file types by their icons. Data file icons are the standard file icon used (plain rectangular document icons). Blocks file icons are rectangular document icons with three rectangles within the bounds of the icon. These rectangles represent the three blocks of source code you can print out on a sheet of paper using the word **TRIAD** (explained in the Editor chapter).

You can load a blocks file from the Finder by double clicking it. When a blocks file is loaded in this manner, MacFORTH is loaded first, then block 1 of the selected file is loaded (more about this later).

Data Files

Data files contain data in whatever format you specify. The data can be stored as a virtual array with no particular format all the way up to fixed fields within fixed records.

Creating a Data File

If the file you have assigned already exists on the disk, there is no need to re-create it; go on to "Read/Writing in a Data File".

To create a new data file on disc, use the **NEW.FILE** command in the following form:

```
          <size>  " <file name>"  NEW.FILE
```

This will create the file on disc and place it into the disc file directory as a "DATA" type file with the specified size. If the file was successfully created, its file number is returned on the stack. If an error was encountered during creation of the file (eg. enough room on the disk, in the catalog, no naming conflicts, etc.) the appropriate error message is displayed, and the system aborts. For example, to create a file named "My Data File" with initial size 100, assigning its file number to the constant **DATA.FILE**, you could execute:

```
          100 " My Data File" NEW.FILE  CONSTANT DATA.FILE
```

Future references to the newly created file can be made using the constant **DATA.FILE**.

Allocating Space in a Data File

There are three methods you can use for allocating space in data:

a) Allocate the space when you create the file (with the **NEW.FILE** command)

b) Don't (let the system do it for you)

c) Both a) and b)

When you create a data file, you can to allocate space for it by specifying the size. Suppose you wanted to allocate enough space for 100 records, each 50 characters in length. The number of bytes needed is 5000 (100 * 50).

To create some space using method b), you can simply start writing data into the file. This appends data to the file, allocating space for the data as needed. Each time you write data into the file, the furthest write operation into the file sets the end-of-file pointer. You can **write** past the end-of-file pointer (and re-set it), but you can't **read** past it. This simply means that you should write data to the last position in the file you will access before trying to read from it.

You can also combine both methods to create space in your file. You may want to allocate a minimum amount of space when you create the file and as the file grows, simply append data to the end, increasing its size.

Reading/Writing in a Data File

MacFORTH supports three data file record types: fixed, text, and virtual. Each type has is own best use and you are free to use any type you like within an application. Fixed record files are the simplest and most useful, text record files make efficient use of disk space for text storage, and virtual record files are the most flexible.

The MacFORTH file system reads and writes data records from a record buffer from/to a file. A record buffer is simply an area in memory that you specify for reading/writing records. To create a record buffer, simply allocate the amount of space needed for the longest record you will read or write.

For example, if you will be accessing data records in a file and know that the maximum record length is 60 bytes, you could create a record buffer by executing:

```
          60  CONSTANT  REC.BUF.SIZE
          CREATE  REC.BUF  REC.BUF.SIZE   ALLOT
```

This phrase created a record buffer called **REC.BUF** and allocated 60 bytes for it. **If you create a record buffer smaller than your record size and read data into it, you could crash the system.** When the data is read from the file, it will continue to overwrite your dictionary, so be sure to allocate enough space. That is why we created the constant **REC.BUF.SIZE** in the above example. When reading or writing, you can specify the size of the buffer as a constant to be sure you use the right size.

You may also use the scratchpad buffer, **PAD**, but be sure to use a reasonable record size to avoid overwriting the end of the object space.

Fixed Record Data Files

Fixed files are made up of records of the same size. This format allows you to access any record in the file by its record number. The records in a fixed file are in sequence starting at record number 0 through the last record in the file.

Specifying Record Size After you assign a fixed file, before you can read or write data in the file, you need to specify the size of each record in the file. Use the **SET.REC.LEN** command in the following format:

```
          <max rec size> <file#>  SET.REC.LEN
```

For example, if you were using fixed record lengths of 37 in fixed file #3 (using the constant **MYFILE**) you would execute:

```
          37  MYFILE  SET.REC.LEN
```

This is the value used by the MacFORTH system when reading/writing records in a fixed file. If you don't specify the record size, you'll get the error message "Fixed Record Length = 0!" when you try to read or write records in the file.

Accessing Records Once you have assigned and opened the file, and allocated a record buffer for the file, accessing records within the file is simple. To read a record into your buffer, you supply the buffer address, record number and file number to the command **READ.FIXED**. For example, to read record 5 from file #3 (represented by the constant **MYFILE**) into a buffer named **REC.BUF**, you would execute:

```
          REC.BUF  5  MYFILE  READ.FIXED
```

Similarly, to write a record, you use the same format. For example, to write record 12 to file # **MYFILE** from a buffer named **REC.BUF**, you would execute:

```
          REC.BUF 12 MYFILE WRITE.FIXED
```

Text Files

Text files are made up of a sequence of text (ASCII characters) records separated by carriage returns. This is an efficient way to store text files because only the space needed for the text is used (no wasted space as may be found in using fixed records for variable length text storage).

Because the records in a text file are variable length, you won't know how long a particular record is until you have read the entire record into your buffer.

Rewinding a Text File
To rewind a text file (set its position pointer to point to the start of the file), use the word **REWIND** in the following format:

```
          <file#>  REWIND
```

For example, to rewind file # **MYFILE** (where **MYFILE** is simply a constant containing the file number), you would execute

```
          MYFILE  REWIND
```

Reading Records in a Text File
Once you have opened the text file you want to use, and created a record buffer for the records, reading and writing records from/to the file is simple. For example, to read the first text record in file number **MYFILE** into a record buffer named **REC.BUF** with length of **REC.BUF.LEN**, you would execute:

```
          MYFILE  REWIND
          REC.BUF  REC.BUF.LEN  MYFILE  READ.TEXT
```

To read the next record in the file, you would execute:

```
        REC.BUF  REC.BUF.LEN  MYFILE  READ.TEXT
```

and so on. After each read operation in a text file, the file pointer is positioned to the first byte of the next record. Subsequent read operations read the next record in the file automatically.

What if your buffer isn't long enough for the record being read? Unlike the fixed record files, you can use a buffer that is shorter than the length of the record being read. (We recommend you use record buffer long enough to accept the longest text record in the file for simplicity.) Let's look at an example to illustrate this point. Suppose that the next record in the text file you are reading from is 10 characters in length, consisting of the following:

```
        Char #:  1  2  3  4  5  6  7  8  9  10
        Chars :  B  o  b     S  m  i  t  h <cr>
```

If you read this record into a buffer of length 10 or more, you will get the entire record and can continue. But, on the other hand, if you read this record into a record buffer of length, say 7, you will only get the first seven characters. To get the rest of the record ("t", "h", and the carriage return), perform a read command just as if the rest of the record was the next record in the file. The read will terminate on the carriage return, so only the 3 characters remaining will be read.

When MacFORTH reads a text record into a buffer, it transfers characters to the buffer one at a time until it encounters a carriage return in the file ("normal" termination) or until the record buffer is full. If the record buffer is full prior to encountering a carriage return, the file pointer is left pointing at the next character to be read from the current text record. Subsequent reads will begin at that character (just as if it were the first character in the record).

Writing Records in a Text File To add records to a text file use the **WRITE.TEXT** command as follows:

```
        <buffer addr>  <record length>  <file#>  WRITE.TEXT
```

For example, to add the record in the buffer **REC.BUF** which is 10 bytes long (including a carriage return at the end) to file number **MYFILE**, you would execute:

```
        REC.BUF  10  MYFILE  WRITE.TEXT
```

When writing text records, you must append a carriage return to the end of the record (EOL). For example, to append a carriage return to the record just written (from the above example), you could execute:

```
        CRLF  1  MYFILE  WRITE.TEXT
```

Virtual Files

Virtual files are the most flexible file format of the three types supported by MacFORTH. Using virtual files, you could re-write each of the existing file structures or create your own new file types. To MacFORTH, a virtual file is simply a virtual array of characters. You can manipulate this array in any way you like.

Accessing Data in a Virtual File

To read data within the file to a buffer, use **READ.VIRTUAL** in the following format:

```
     <buffer addr>  <length>  <file addr>  <file #>  READ.VIRTUAL
```

The only new parameter you may not recognize is <file addr>. This is the offset from the start of the file where you would like to start reading data. For example, to read 100 bytes from the file number 6 (represented by the constant **MYFILE**) starting at the beginning of the file into the record buffer **REC.BUF**, you would execute:

```
          REC.BUF 100  0 MYFILE READ.VIRTUAL
```

To read 7 bytes from the same file, starting at the 23rd element in the file into the record buffer **REC.BUF**, you would execute:

```
          REC.BUF 7 23 MYFILE READ.VIRTUAL
```

Writing data into the file is done in a similar manner using the word **WRITE.VIRTUAL** in the following format:

```
          <buffer addr> <length> <file addr> <file#> WRITE.VIRTUAL
```

For example, to write 30 bytes of data from **PAD**, starting at position 100, you would execute:

```
          PAD  30  100  MYFILE  WRITE.VIRTUAL
```

Blocks Files

Blocks files contain program source code. Each file is made up of a sequence of blocks (1024 bytes) numbered from zero through the maximum block in the file.

Creating a Blocks File

If the file you have assigned already exists on the disk, there is no need to re-created it; go on to "Opening a Blocks File."

To create a new blocks file, use **NEW.BLOCKS.FILE** in the following format:

```
<# of blocks> " <file name>"  NEW.BLOCKS.FILE
```

This will create a new blocks file on disk and place it into the disc file directory. If the file was created and allocated successfully, the file number for the new file is left on the stack. If an error is encountered in the process, an error message is displayed and the system aborts.

As with the **NEW.FILE** command, you may want to create a constant value for the file number, or if you aren't going to use it, simply drop it from the stack. Here's an example to create a new blocks file named "Game Blocks", allocating 12 blocks to it and creating the constant **GAME.BLOCKS** for future references to the file:

```
12  " Game Blocks"  NEW.BLOCKS.FILE  CONSTANT GAME.BLOCKS
```

Changing the Size of a Blocks File

Once you have allocated space to a blocks file, you can change the size of the file with the **APPEND.BLOCKS** command used in the following format:

```
<# of blocks> <file#> APPEND.BLOCKS
```

where <#of blocks> is positive to add blocks, or negative to delete blocks from the specified blocks file. For example, to add 6 blocks to the file identified by the constant **MY.FILE**, you would execute

```
6   MY.FILE  APPEND.BLOCKS
```

or to delete 3 blocks from that file:

```
-3  MY.FILE  APPEND.BLOCKS
```

Accessing Program Source Code in a Blocks File

To access the data within the file as a blocks file, you select it as the "current blocks file." To select a file, use the **SELECT** command in the following format:

```
          <file#>  SELECT
```

This command selects the specified file as the current file for block access. Once opened, you can select any blocks file to be the current blocks file with this command. If you try to select a data file as the current blocks file, the error message "Not a Blocks File!" is displayed. We recommend that you use the word "blocks" in the name of your file to distinguish it from other files on your disk (ie. "Graphics Blocks" or "Checkbook Blocks", etc.).

When executed, **SELECT** saves the block buffers and the file information out on the disk, insuring that any unwritten data from the previous blocks file is saved, and then selects the specified file as the current blocks file.

The MacFORTH word **USE"** is provided for convenience when you want to edit a blocks file. Used in the form

```
          USE"  <file name>"
```

the file specified is opened, and selected as the current blocks.

MacFORTH Blocks File Structure

MacFORTH reserves the first two blocks in a file (blocks 0 and 1) for a special purpose. Block 0 is used as a comment block for the file and can't be loaded. Block 1 is used as a load block for the entire file.

Use block 0 to make notes about the file, current revision of the program, etc. This is handy for later reference.

Use block 1 as a load block for your application. This important because when you open (by double clicking) a MacFORTH blocks file from the Finder, MacFORTH selects the file and loads block 1.

Including a File

The word **INCLUDE"** allows you to load another blocks file. The specified file will be opened and loaded (by loading block 1). You can use **INCLUDE"** from any file to load another file, then continue loading the original file. For example, if you had the source code to a file named "Checkbook Blocks", you could load it by executing

```
INCLUDE" Checkbook Blocks"
```

INCLUDE" may be nested . This means that a file that is being included can include a file itself.

When **INCLUDE"** is executed, the specified file is assigned to the first available FCB.

Closing a File

When you have finished using a file, you should close it. This ensures that all data is written to the disk and that the file system updates all necessary information about the file. To close a file, simply execute the **CLOSE** command using the file number to be closed. For example, to close file# 7, you would execute:

```
7  CLOSE
```

You should always check the I/O result code when you close a file to be sure it was properly closed.

Deleting a File

To remove a file from the disk (and destroy all data contained in the file), use the **DELETE** command. Once a file is deleted, you cannot recover the data from it, so use this command with caution. To delete a file from the current disk, execute the **DELETE** command as follows:

```
<file#>  DELETE
```

Ejecting a Disk

You can eject a disk from the drive with the command

```
          INTERNAL EJECT
```

To eject the disk in the external drive (if present) execute

```
          EXTERNAL EJECT
```

Mounting a New Volume

To mount a new volume, simply eject the disk that is in the drive and insert the desired disk (volume). MacFORTH will automatically mount the new volume.

References to Volumes

As we have said, you can reference a volume by name when opening a file by simply inserting its name followed by a colon before a file name. A volume may also be referenced by volume number. Volume numbers 0, 1 and 2 refer to whatever volume was the boot volume (volume #0), and the volumes residing in the internal drive (volume #1) and the external drive (volume #2).

Assignment of specific volume numbers start at 0 for the default drive and increase by -1 in the order order that each new volume is mounted (ie. the first volume mounted is 0, the second is -1, the third is -2, and so on).

Specific volumes may be ejected, or have their directories displayed by using the volume number.

Advanced File System Topics

This section discusses some of the inner workings of the MacFORTH file system. It is intended for the advanced user. You do **not** need to read this section to use the file system.

File Control Blocks MacFORTH uses an array for each file number used. The information in this array is required by the Macintosh file commands. You can examine and alter (at your own risk!!) any information about a file by examining its file control block.

The command **>FCB** returns the address of the fcb array for the given file number. Each array is 90 bytes long.

File Pointer The basis of the MacFORTH file system is the word **POINT** which points into a file. **POINT** allows you to point anywhere in a file, randomly, sequentially, relative to the front, back or anywhere in-between. **POINT** is used in the following format:

```
<position> <position mode> <file#> POINT
```

Position Modes There are four position modes for use with **POINT** :

Mode	Position Type
FROM.START	position relative to the start of the file
FROM.END	position relative to the end of the file
FROM.CURRENT	position relative to the current file position
VIRTUAL	position to any specified location in the file

To clarify this point, let's look a some examples (we'll use the dummy constant **FILE#** to represent a valid file number):

a) position at the start of the file:
```
    0 FROM.START FILE# POINT
```
b) position at the end of the file
```
    0 FROM.END FILE# POINT
```
c) position at the 17th character in the file
```
    17 FROM.START FILE# POINT
```
d) position 4 characters before the current position in the file
```
    -4 FROM.CURRENT FILE# POINT
```

Note: The above three operators set the file mode to text. This means that the file pointer will be positioned where you specify, **but** until you change the mode (if text is not the desired mode), you will be reading and writing text records (terminating on carriage returns).

You can also use the position mode **VIRTUAL** to point to any byte in the file. Using the above examples:

a) position at the start of the file
```
    0 VIRTUAL FILE* POINT
```
b) position at the end of the file
```
    <max * of bytes in file>  VIRTUAL FILE* POINT
```
c) position at the 17th character in the file
```
    17 VIRTUAL FILE* POINT
```
d) position 4 characters before the current position in the file
```
    CURRENT.POSITION  4 -  VIRTUAL  FILE* POINT
```

File Name Length The name given to a file is any string of up to 255 characters in length. Invalid characters include colon (:) and double quote (").

Volume Name Length A volume name is any string of up to 26 characters in length and terminated by a colon (:).

Maximum File Length For practical purposes, the maximum file size is limited only by the amount of available space on a disc. The absolute file size maximum is 16 megabytes (16,722,216 bytes). The maximum record size to be read at one time is 64 kilobytes (65,535 bytes), but is currently limited to the amount of memory available.

Appendix A: Example File Usage

In order to simplify your task of using the file system in your application, we present the following simple example as a template. The example is a simple system of keeping track of three people (by their last names) and their ages in the fixed file "Ages File". Their names and ages are:

Name	Age
SMITH	26
JONES	38
WILSON	31

and we will translate them to:

```
      CREATE REC1 26 C, ," SMITH "
      CREATE REC2 38 C, ," JONES "
      CREATE REC3 31 C, ," WILSON"
```

(Note that we are simply placing the data into the dictionary for the purpose of example. This data would normally be accessed via another file or input directly from the keyboard.)

Now, continue with creating and opening the file:

```
      0  " Ages File"  NEW.FILE   CONSTANT AGES.FILE
```

The buffer used to read the records into:

```
      8  CONSTANT  AGES.REC.SIZE
      CREATE AGES_BUF  AGES.REC.SIZE  ALLOT
```

Set the fixed record size:

```
      AGES.REC.SIZE  AGES.FILE  SET.REC.LEN
```

Next, we'll write the records into the file:

```
      REC1  1  AGES.FILE  WRITE.FIXED  ?FILE.ERROR
      REC2  2  AGES.FILE  WRITE.FIXED  ?FILE.ERROR
      REC3  3  AGES.FILE  WRITE.FIXED  ?FILE.ERROR
```

(Notice that we didn't need to set the end of file pointer; it was done automatically by writing data at the end of the file each time. The file system automatically increased the file size.)

Here's a word which will read each record and print the information:

```
: DISPLAY.RECORD  ( --- | display data for the current rec)
   AGES_BUF 1+ COUNT TYPE        ( display the name )
   ."  is "   AGES_BUF C@  .     ( display the age  )
   ."  years old."    ;


: SHOW.AGES    ( --- )     4 1
     DO    AGES_BUF  I  AGES.FILE  READ.FIXED   ?FILE.ERROR
             CR  DISPLAY.RECORD
     LOOP   ;
```

Suppose you wanted to change JONES' age to 39?

```
AGES_BUF 2 AGES.FILE READ.FIXED       ( read Jones' record )
39 AGES_BUF C!                        ( change the age )
AGES_BUF 2 AGES.FILE WRITE.FIXED      ( re-write the record )
```

Appendix B: File System I/O Result Codes

The following result codes are returned by the system ROM after an Input/Output operation has taken place:

Result Code	Meaning
0	No error. Operation completed successfully.
-33	Directory full
-34	Disc full
-35	No such volume
-36	Disc I/O error
-37	Bad filename
-38	Fork not open
-39	End of fork
-40	Position error. Tried to position before start of file.
-41	Memory full
-42	Too many forks - more than 12 forks open
-43	File not found
-44	Disc write protected
-45	File locked
-46	Volume locked
-47	One or more files are opened
-48	Duplicate file name
-49	Fork already opened with read/write permission
-50	No drive number specified
-51	No file assigned, reference number specifies nonexistent access path
-53	Volume not on-line
-54	Locked volume can't be written to
-55	Volume already mounted and on-line in drive
-56	Invalid drive number - number specified doesn't match an existing drive
-57	Invalid disc directory
-58	External file system; can't recognize volume
-59	Problem during rename
-60	Master directory block is bad
-61	Read/write or open permissions - writing not allowed

Chapter 10: Printer/Serial

Overview

MacFORTH allows you to output anything that you can put on the screen, both characters and graphics, to an Apple Imagewriter printer. If you have any other type of printer, refer to the "Other Printers" section of this chapter.

Text Output

Any character output to the screen can also be output to the printer. To do this, use one of three methods:

a.) Select the "Printer" item from the "Options" menu. Output is then directed to both the printer and the screen.

b.) Press ⌘P (a shortcut for selecting the "Printer" item from the "Options" menu).

c.) Execute `PRINTER ON` to activate the printer.

To disable output to the printer, you can use A or B above (they actually toggle the printer function) or execute

```
        PRINTER OFF
```

If you are doing any special formatting on the printer and don't want the output to appear on the screen, execute:

```
        PRINTER.ONLY  CONSOLE  !
```

To return output to both the printer and the screen, execute:

```
        MAC.CON  CONSOLE  !
```

PRINTER.ONLY does what its name implies. In the event of an error or if the end of the input is reached MacFORTH always returns to the console as the output device.

You can also direct any string to the printer with the word **PRINT**. **PRINT** works just like **TYPE**, only the string is output to the printer instead of the display.

Many printers need a termination character (like CR or LF) before they will print the data sent to them. To output a carriage return or line feed execute

```
        CRLF 2 PRINT  ( CR,LF)
        CRLF 1 PRINT  ( just CR)
```

Window/Screen Output

MacFORTH allows you to dump the contents of either only the active window or the entire screen to an Imagewriter printer. There are two methods of dumping the entire screen:

a) Depress the caps lock key and press shifted ⌘4

b) Execute **PRINT.SCREEN**

To dump only the contents of the front window use one of the following two methods:

a) Release the caps lock key and press shifted ⌘4

b) Execute **PRINT.WINDOW**

It is also possible to print just a portion of the current window with the word **PRINT.BITS**. Used in the form

```
<top> <left> <bottom> <right> <bitmap addr>  PRINT.BITS
```

the rectangle specified by <top> <left> and <bottom> <right> in the active window will be printed. The bitmap for a window is offset 2 bytes into the window record, so the address for the bitmap is GET.WINDOW 2+

For example, to print the contents of the upper left corner of the window, execute:

```
0 0 50 60  GET.WINDOW  2+  PRINT.BITS
```

Other Printers

For best results, we strongly suggest you purchase an Apple Imagewriter printer. If you choose to use another type of printer, you will have to either provide your own cabling and printer configuration or arrange with someone who can.

Note: CSI does not guarantee that the instructions provided will enable you to interface to any printer other than the Imagewriter. The following information is intended to provide background information to individuals who have fabricated cables for and interfaced printers to other computers. It is not something that be attempted by inexperienced users. Beyond supplying this background information, CSI will not support non-Imagewriter printers.

Interfacing to Another Printer

In order to interface your non-Imagewriter printer to the Macintosh, you will need the following:

a) a printer with an RS-232C Serial interface, and

b) a specially fabricated cable to connect between the printer and the Mac (refer to ST.MAC Magazine, 1984, pg.44 for Mac pinouts)

c) be sure to satisfy the control signal requirements of your printer (ie. DSR, CD, RTS)

Printer Port Configurations

Default text output to the printer port occurs at 9600 baud, no parity, 8 data bits, 1 stop bit. Handshake protocol for output flow control is XON/XOFF. If your printer cannot be configured to this format, you will need to reconfigure the Mac printer port to a format your printer is capable of. Use:

```
        <#stop bits> <parity> <#bits> <baud rate>  CONFIGURE.PRINTER

where   #stop bits    1,2      = 1 stop bit, 2 stop bits
        parity        0,1,2,3  = none,odd,none,even
        #bits         5,6,7,8  = # of data bits
        baud rate              = 75 - 57600
```

For example:

```
        1 0 8 1200 CONFIGURE.PRINTER
```

reconfigures the printer port for 1 stop bit, no parity, 8 data bits, 1200 baud.

Graphics Output

Unfortunately, the industry has no real standards for dumping graphics to a printer. In order to output graphics data to your printer, you will need the following:

a) The ability to output text as described above (consider a printer buffer if necessary).

b) A complete understanding of the way in which your printer accepts graphics information.

c) You will then have to write a program which determines which bits are set in the desired display area, format them into a output buffer which will be compatible with your printer, and then dump successive output buffers to the printer. Use the MacFORTH graphics word **GET.PIXEL** to determine the state of each dot on the screen.

Serial Interface

Starting on block15 of the "FORTH Blocks" file on the MacFORTH system disc contain source code for the Macintosh serial communications port (the phone icon). This code is followed by an example of a minimal terminal emulator program capable of communicating over the serial port with a remote host computer, as well as upline and downline loading of text files. In the remainder of this section we will discuss each of the primitive serial interface operators, and discuss how they are used in the terminal emulator program.

We have provided the serial communications in source code form for three reasons:

First, it is optionally loadable. If you don't want to use it, you aren't penalized in memory usage.

Second, many users of MacFORTH are newcomers to FORTH. This provides another example of FORTH source code. We encourage you to follow our example of spreading your applications source code over many blocks, leaving plenty of "white space" in your blocks. Note that each word is commented with both what is expected on the stack and a brief description of the action it takes. Many novice FORTH programmers try to cram as much as possible into a single block of source code, making it unreadable. Disks are cheap compared to the headache of trying to unravel an overstuffed block!!

Third, for those users who have "Inside Macintosh", this is a good example of how to interface to a device driver entirely in high level FORTH.

Serial Interface Primitives

SERIAL.FILE# -- addr

Variable containing the file number to use for serial I/O operations. Actually, two files are required to support full duplex operations.

SERIAL.IN -- file#

Returns the file number for the input side of the serial interface.

SERIAL.OUT -- file#

Returns the file number for the output side of the serial inteface.

INPUT.SIZE -- size

Constant containing the size of the serial input type ahead buffer. Change it to suit your requirements.

INPUT.BUFFER -- addr

Returns the address of the input buffer.

SERIAL.OPTIONS -- addr

Returns the addres of the array used to configure the serial interface protocol.

Offset (bytes)	Description
0	XON/XOFF handshake enabled if byte is non-zero
1	CTS handshake enabled if byte is non-zero
2	XON character for software handshake
3	XOFF character for software handshake
4	Input abort codes: bit 4 = parity error bit 5 = overrun error bit 6 = framing error
5	Status change generates event bit 7 = BREAK state change bit 5 = CTS state change
6	Enable XON/XOFF input flow control if byte is non-zero

After modifying the contents of this array, use **BAUD** (discussed later) to put the new options into effect.

OPEN.SERIAL addr\cnt\file# --

Opens serial device driver on the specified file#. (Note: **?FILES** will show the serial files as ".AIN" and ".AOUT".) addr and cnt specify the address and length of the input buffer to be used for type ahead. This buffer is used to make up for the time it takes to scroll up all bits within the window.

To change from the comm port (phone icon) to the printer port (printer icon), replace ".AIN" and ".AOUT" with ".BIN" and ".BOUT" within the definition of **OPEN.SERIAL**.

S.TYPE addr\cnt --

Analagous to **TYPE** or **PRINT**. Output is sent to the serial port.

S.EXPECT addr\cnt --

Analagous to **EXPECT**. No character editing (eg. backspace) is performed.

S.?TERMINAL -- n

Returns n as the number of characters available in the input buffer. Returns 0 if none are available.

S.STATUS -- stat2\stat1

Returns the serial device status.

Stat1:

bit 30	framing error
bit 29	hard overrun
bit 28	parity error
bit 24	soft overrun (input buffer overflow)
bits 16-23	non-zero: XOFF received to stop input data
bits 8-15	read command pending
bits 0-7	write command pending

Stat 2:

byte 0	non-zero XOFF flag
byte 1	non-zero CTS flag

S.?READY -- flag

Returns a true flag if the serial driver is able to output (not held off by CTS or XOFF).

S.KEY -- char

Reads char from the serial port. If no characters are available, **S.KEY** waits until one is sent.

S.EMIT char --

Writes char to the serial port. Waits if not ready until ready for output.

S.BREAK ---

Transmits a break signal to the remote computer.

BAUD baud rate --

Opens the serial port if necessary and sets the baud rate, input buffer, and communications options.

Using the Serial Interface

Before attempting to input or output to the serial port, you first need to set the baud rate. For example

```
      300 BAUD
```

initializes the serial port, setting the baud rate and communications options.

Serial Output

To output a character to the serial port, use **S.EMIT**. For example

```
      65 S.EMIT
```

will transmit the character "A" out to the serial port. Refer to the ASCII chart at the end of the manual for a complete listing of ASCII codes.

To output a string to the serial port, use **S.TYPE**. For example

```
      CRLF 1 S.TYPE
      " LOGON" COUNT S.TYPE
```

will output a carriage return, then the string "LOGON" to the serial port.

Serial Input

S.?TERMINAL returns the number of characters available in the input buffer. To input a single character use **S.KEY**. To input a string of characters, use **S.EXPECT**.

You can combine the function of **S.?TERMINAL** and **S.EXPECT** to input the entire string in the serial input buffer:

```
PAD  S.?TERMINAL  S.EXPECT
```

Using the Terminal Emulator

Refer to the first screen of the terminal emulator code (at the end of the serial interface code) for instructions on how to operate it.

Chapter 11: Advanced Topics

In this chapter we will discuss a variety of MacFORTH features which you will find useful in the course of programming.

Time and Date Functions

Your Macintosh maintains a count of the number of seconds that have passed since January 1, 1904 in its own internal counter. This counter is updated every second automatically by the computer and can be read by executing the word **@CLOCK**. To facilitate using this feature, we have provided you with the following words to display the time and date:

.TIME$ ---
Displays the current time (as read from the internal clock) and displays it in the following format:
HH:MM:SS XM

.DATE$ ---
Displays the current date (as read from the internal clock) and displays it in the following format:
MM/DD/YY

GET.TIME$ addr --
Copies the 11 byte time field ("HH:MM:SS XM") to addr. Be sure that you have 11 available bytes at addr as it will be overwritten.

GET.DATE$ addr --
Copies the 8 byte date field ("MM/DD/YY") to addr. Be sure that you have 8 available bytes at addr as it will be overwritten.

For more information on using the internal clock for display of time and date, refer to the MacFORTH Glossary entries for:

```
FMT.DATE$   FMT.TIME$   DAYS>   ?SECONDS   ?DAYS
```

Timer Functions

You can also use the clock as a timer. For example, to see how long it takes to display the entire words list of the current dictionary, you could execute:

```
@CLOCK  WORDS  @CLOCK  SWAP - CR .  ." Seconds"
```

or to wait a specified number of seconds before continuing:

```
: WAIT  ( # of seconds -- )
   @CLOCK  +
    BEGIN  @CLOCK  OVER =   UNTIL   DROP   ;

30 WAIT
```

TRACE and DEBUG Features:

To facilitate debugging your program (if it has any bugs), we have provided you with an extensive set of tools for tracing and locating the problem.

Interrupt Button Support

When the user presses the interrupt button (the second button on the programmers buttons on the left side of the Mac) while MacFORTH is in control, MacFORTH locks out interrupts for a few seconds and then aborts the current operation. This action will recover from most unterminated loops and return control to the MacFORTH window. For example, try a definition like:

```
        : ENDLESS BEGIN CR." again and again..." AGAIN ;
        ENDLESS
```

Now reach around and press the interrupt button (**not** the reset button).

DEBUG Option

The debug option is present on the options menu bar. A check mark indicates the debug option is active. The keyboard equivalent command is command D.

When the debug option is on, the text interpreter will check the stack depth after completion of each request. If any items are left on the stack, they are displayed using .S in the following format

```
        [depth] \ 3rd stack item \ 2nd stack item \ top stack item
```

The 3rd and 2nd stack items are only displayed if they exist. Refer to the trace option for other features of the debug option.

TRACE Option

The trace option provides a compile time elective trace feature. Basically this option instructs the compiler to compile new definitions in such a way that when they are executed, the name of each word will be printed along with the depth and contents of the stack. The trace option may be set and cleared via the options menu bar. Pull down TRACE to toggle this function.

For example, execute

```
        DEBUG ON
        TRACE ON

        : TEST  10 0 DO   ." * " I  .  LOOP ;

        TEST
```

Because the definition was compiled with the trace option on, when it executes, each word that is executed is preceded by printing its name and followed by printing the contents of the stack. (You can use the Menu Bar to halt and resume output.)

The debug option enables and disables the run-time trace option's output. Now execute

```
        DEBUG OFF
        TEST
```

and you will see that the trace feature was not executed because the debug option was off.

NOTE: The trace option forces compilation of the trace feature into each word when it is turned on. The trace output is generated at run-time. This means that a great deal of overhead is carried with each word when it is executed with the trace option on. To get accurate timing information in time-critical operations, and for production applications code, disable the trace feature and re-compile the code.

Remember, the TRACE option is altered by command D. You can toggle the trace function on and off during output by pressing command D (or by selecting the Debug item from the Options menu).

UNIQUE.MSG Option

The text interpreter searches the current words in the dictionary when a new definition is created. If a new entry with a name field the same as a prior entry is created, the interpreter can optionally display the error message

```
        ISN'T UNIQUE
```

The phrase

```
        UNIQUE.MSG  ON
```

enables output of this warning message when a word is re-defined (or given the same name as a prior word). The phrase

```
        UNIQUE.MSG  OFF
```

disables output of this message. For example, execute the following

```
        UNIQUE.MSG  ON
        :  TEST  ;
        :  TEST  ;

        UNIQUE.MSG  OFF
        :  TEST  ;
```

You normally want to operate with the UNIQUE.MSG option enabled, however, when loading production code with known re-definitions, you may choose to disable this message.

LOWER.CASE Option

If you enter MacFORTH words in lower case, the text interpreter normally converts them to upper case before looking them up or creating a new dictionary entry. This allows you to reference a word by typing its name in upper or lower case. The phrase

```
        LOWER.CASE  ON
```

defeats this automatic conversion and allows you to define MacFORTH words in lower case that have different name fields than their upper case equivalents. The phrase

```
        LOWER.CASE  OFF
```

causes words to be again converted to upper case. The default state of this switch (at startup) is OFF.

QUIET Option

MacFORTH normally sounds the beeper to attract your attention to an error. In some environments, this noise may be inappropriate. To quiet the beeper on errors, enter

```
      QUIET  ON
```

to sound the beeper on errors, enter

```
      QUIET  OFF
```

Default setting for this switch is OFF at startup.

User Specified Error Handlers

MacFORTH allows you to dynamically install and remove handlers which intercept errors defined by **ABORT"** or **ERROR"** . Error handler entry points, specified by **TRY** and **ON.ERROR** , are dynamically installed and remain active for the current definitions. If an **ABORT"** occurs or a **RECOVER** attempt is made within that defintion or any definition which it executes, the specified error handler will be invoked (unless another handler has been invoked at a lower level). When the current definition completes, error handling specific to that definition is replaced by that of the next higher level. Thus, error recovery is fully nested, and the scope of any error handler specified within a definition is relevant only to that definition (or those it references). For example,

```
          :  OOPS!  0 0 W/MOD ;
          OOPS!
```

invokes a division by zero processor exception handler to execute the following (by default):

```
          ABORT" ZERO DIVIDE TRAP ! "
```

Error Recovery

Because no exception handler was specified, the default error action occurred. By using **ON.ERROR** to specify a new handler, you can override the default action. Try:

```
          : TEST    ( --- )
               ON.ERROR  ." TEST ABORTED "  ABORT   RESUME
                  ." TEST STARTED "  OOPS!
                  ." TEST COMPLETED " ;

            TEST
```

What happened? In the definition of **TEST**, you created an error handler to process any abort conditions (defined using **ABORT"** or **ERROR"**). The phrase:

```
          ON.ERROR ." TEST ABORTED " ABORT RESUME
```

defined the error handler to display the message "TEST ABORTED" and then execute **ABORT** when an error occurred.

When the zero divide trap (caused by executing **OOPS!**) was encountered, MacFORTH executed the new error handler (that you installed in **TEST**) instead of the default. Try

```
     OOPS!
```

Newly defined error handlers are in place **only** during execution of the word which defines them with **ON.ERROR**. After the word finishes execution, the new error handler is discarded. This allows you to nest error recovery routines.

In **TEST**, the new error handler executed **ABORT**, which aborted execution back to the interpreter. Your error handler will re-execute the code following **RESUME** if you don't execute **ABORT** (or some equivalent). For example, try:

```
   : TRY&TRY.AGAIN  ( --- )
        ON.ERROR CR ."    New Error Handler..."  RESUME
        CR ." Try & try again code..."  OOPS!
        ." Finished!!"  ;
   TRY&TRY.AGAIN
```

TRY&TRY.AGAIN will continue executing until you execute ⌘A (or select "Abort" from the "Options" menu). Why? Take a close look at the code. First, a new error handler was installed via

```
   ON.ERROR CR ."    New Error Handler..."  RESUME
```

Notice that there is no **ABORT** to halt execution. After MacFORTH executes **OOPS!**, it is directed to execute the new error handler, then resume executing the code after **RESUME**, which executes

```
   CR ." Try & try again code..."  OOPS!
```

which causes an abort, which causes the new error handler to execute, which resumes, and so on (and so on...).

(Notice that the end of **TRY&TRY.AGAIN** -- the message "Finished!!" -- will never be executed.)

Disabling Error Recovery

How does MacFORTH know if you have posted (defined) your own error handler? The variable **RETRY** points to the current error handler. If **RETRY** is zero, it implies that MacFORTH should use the default error handler. Non-zero **RETRY** tells MacFORTH you have posted your own error handler (it is actually the address of the new error handler).

You can cancel a posted error handler at any point with the phrase

```
      RETRY OFF
```

As we explained above, this will instruct MacFORTH to use the default error handler. For example, try:

```
          : TRY.ONCE  ( --- )
              ON.ERROR CR ." Error Encountered!!" CR   RETRY OFF
              RESUME
              CR  ." Trying... " OOPS! ;

          TRY.ONCE
```

Let's follow what happened when you executed **TRY.ONCE**;

```
      ON.ERROR CR ." Error Encountered!!" CR   RETRY OFF
      RESUME
```

set up the new error handler;

```
      CR ." Trying..."
```

displayed the message "Trying...", and

```
      OOPS!
```

caused an error condition to occur.

The first time through, the new error handler was installed, the message "Trying..." was displayed, and **OOPS!** caused an error. When the new error handler was executed, it displayed the message "Error Encountered!!", disabled itself (by setting **RETRY** to zero), and then continued after **RESUME**.

The second time through (executing the code after **RESUME**), the message "Trying..." was again displayed and **OOPS!** caused an error. This time, however, MacFORTH saw that **RETRY** was zero and executed the default handler which caused the system to abort with the message "ZERO DIVIDE TRAP !".

Setting **RETRY** to zero only affects the most recently defined error handler (which is automatically removed at the end of the current definition anyway). Any previously defined error handler will be re-installed when the current definition is completed, allowing nesting of error handling routines.

Unconditional Error Recovery

You can unconditionally recover at the most recently specified error handler with the word **RECOVER**. Try the following example:

```
        :  RECOVER.TEST  ( f -- )
             ON.ERROR  RETRY OFF  1 ABORT"  Aborting RECOVER.TEST "
             RESUME
              IF   RECOVER   ELSE   20 SYSBEEP   THEN  ;

        0  RECOVER.TEST
        1  RECOVER.TEST
```

MacFORTH can even detect when you try to fool it!!

```
        :  NICE.TRY!  ."  YY"  RECOVER  ;
        NICE.TRY!
```

The error message "ILLEGAL RECOVERY ATTEMPTED" indicates that an attempted was made to recover with no handler posted.

Here's another way to specify an error handler:

```
        :  TRY.IT ( --- )
              2 TRY 1- ." XX"  DUP
                IF  NICE.TRY!  THEN
              ."  ZZ"  ;
        TRY.IT
```

ON.ERROR posts a handler and jumps over it, **TRY** posts a handler and continues to execute. In either case the stack pointer is returned to the depth that it was when the error handler was identified. This technique is most often used to identify the last ditch error handler in a fault tolerant system. TRY may be used to restart the current program function in case of an unexpected error condition.

```
            ______________________
           |          0           |
           |                      | <--
           |                      |    |    Recovery Stack Frame
          //                     //    |
           |______________________|    |
           |______________________|    |
           |   Prior Retry        |____|
           |______________________|
           |   Recovery SP        |
           |______________________|           User Variable
           |   Recovery IP        |               RETRY
           |______________________|              _______
           |                      |             |       |
           |  Address of NO.RETRY | <-----------|       |
           |______________________|             |_______|
           |                      |
          //                     //
           |______________________|
     RP--> |                      |
           |______________________|
```

This stack frame approach allows you to specify your own error handler at any level without disrupting a handler posted at a higher level. When the current definition completes, the posted handler is automatically replaced by the immediately higher level (if present).

The list of stack frames is terminated by zero which, when RETRY points to it (the zero entry), indicates that the default error handler is to be used.

Memory Allocation

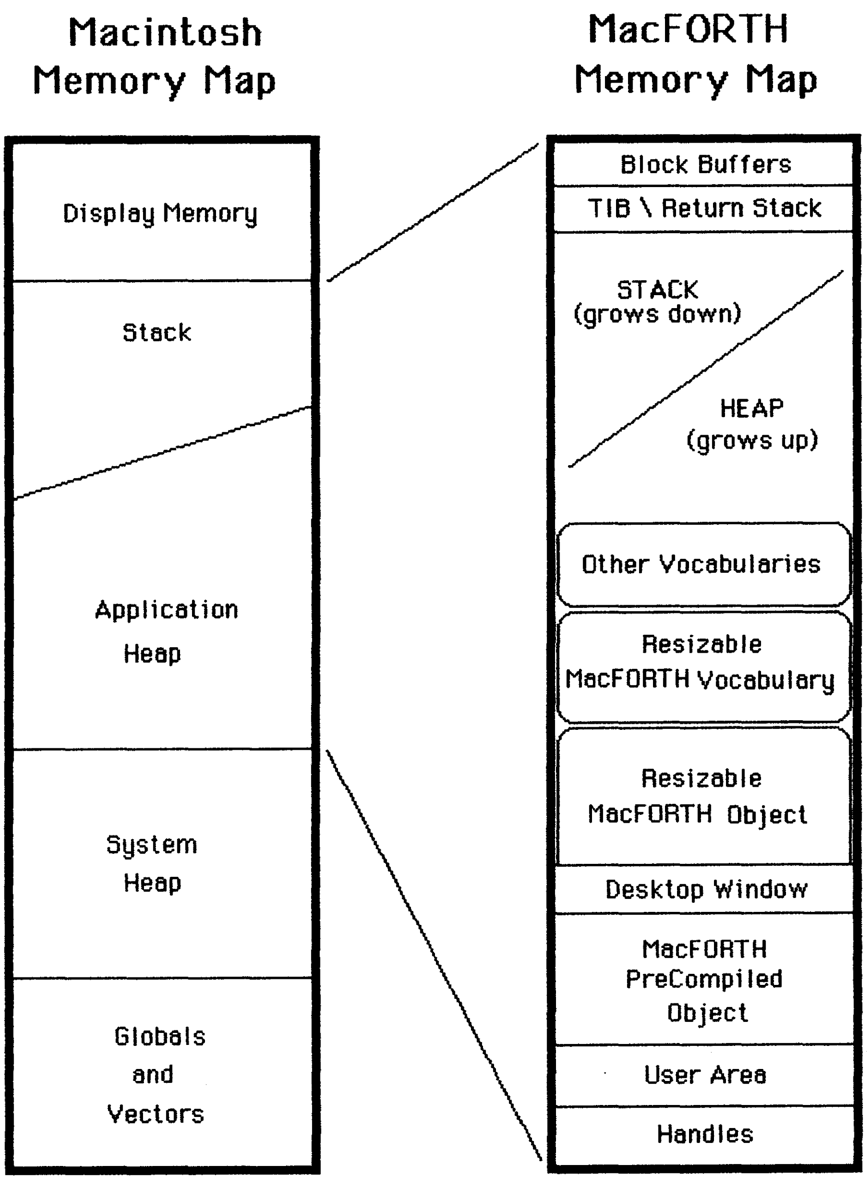
Macintosh memory is partitioned into the five major areas shown in the Macintosh and MacFORTH Memory Maps that follow. The areas titled "Application Heap" and the stack are all that you need concern yourself with. The remaining areas support system functions normally outside the scope of applications programs. The applications heap area is a chunk of memory under the control of the toolbox memory manager.

When writing MacFORTH programs, you control the amount of memory allocated to your current object and vocabulary data structures. When MacFORTH is loaded into memory from disc, it is placed by the toolbox memory manager at the base of the applications heap. The applications heap is just a pool of memory from which programs can request variable length chunks.

The memory manager will attempt to satisfy your request by looking at all of the available pieces in the heap and if a big enough piece isn't available, it will reshuffle the heap until it can put together enough smaller chunks to satisfy your request. You can also ask the memory manager to increase or decrease the size of an existing chunk of memory.

After it is loaded, and the desktop window is initialized, MacFORTH asks the memory manager to allocate a chunk of memory to put programs and data in. Because the object area will contain executable code, it must be locked down in memory, while its size may still grow and shrink.

A default allocation of 8K of object space and 9.5K of FORTH vocabulary space is made.


Macintosh Memory Map
Display Memory
Stack
Application Heap
System Heap
Globals and Vectors
MacFORTH Memory Map
Block Buffers
TIB \ Return Stack
STACK (grows down)
HEAP (grows up)
Other Vocabularies
Resizable MacFORTH Vocabulary
Resizable MacFORTH Object
Desktop Window
MacFORTH PreCompiled Object
User Area
Handles

Vocabulary Data Structure

MacFORTH departs significantly from other FORTH systems in how it handles word lists (vocabularies). Most other FORTH systems intermingle name, code and data structures within the dictionary. While this technique greatly simplifies reclaiming dictionary space via **FORGET**, it requires that you metacompile production programs to separate name fields from code and data structures. MacFORTH maintains name fields in a separate relocatable heap data structure.

A compile program is then able to purge this data structure from the heap, effectively reclaiming the space typically required by FORTH name fields.

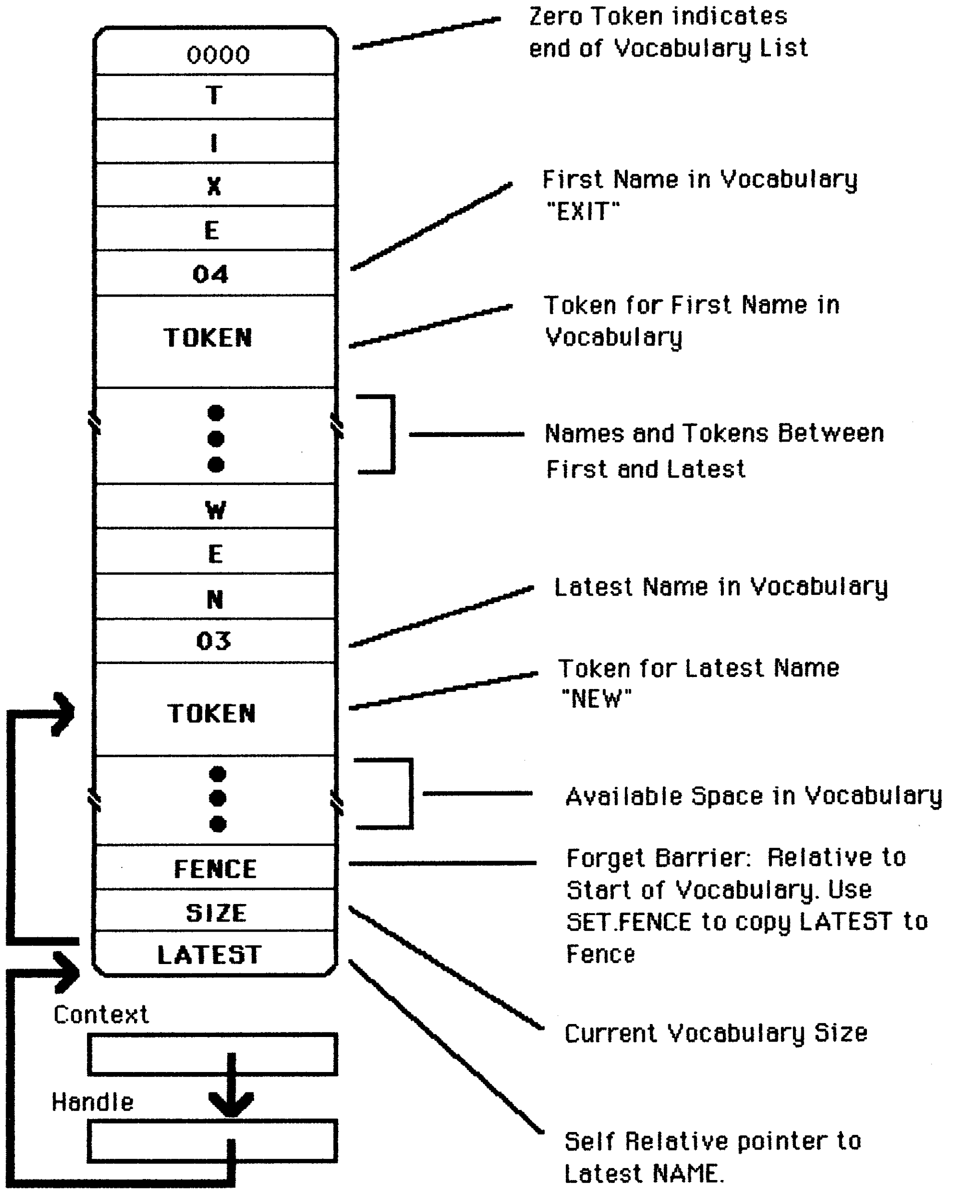
When a word is defined in MacFORTH, its "head" (the text for the name it its associated token) is placed into the **CURRENT** vocabulary. The "body" (its execution and data structures) are placed into the object area.

CONTEXT, **CURRENT**, and **TRUNK** contain the address of a handle to a vocabulary data structure within the vocabulary. The first four bytes contain a self relative offset to the token field of the most recent definition. Token fields may occur on odd byte boundaries, and are followed by the name of the word (which is preceded by its length). Bits 6,7, and 8 of the count byte are used by MacFORTH to contain word precedence. Because MacFORTH uses natural length names (up to 32 bytes long), there is no typical FORTH link field, as the location of the next token can be computed from the name field. A zero token at the bottom of the vocabulary signifies the end.

The following MacFORTH words relate to vocabulary management:

```
    VOCABULARY          -LATEST
    APPEND              BEHEAD
    DEFINITIONS         AXE
    RESIZE.VOCAB        FIND
    MINIMUM.VOCAB       NFA
```

MacFORTH Vocabulary Structure


0000
T
I
X
E
04
TOKEN
W
E
N
03
TOKEN
FENCE
SIZE
LATEST
Context
Handle
Zero Token indicates end of Vocabulary List
First Name in Vocabulary "EXIT"
Token for First Name in Vocabulary
Names and Tokens Between First and Latest
Latest Name in Vocabulary
Token for Latest Name "NEW"
Available Space in Vocabulary
Forget Barrier: Relative to Start of Vocabulary. Use SET.FENCE to copy LATEST to Fence
Current Vocabulary Size
Self Relative pointer to Latest NAME.

Character Cursor Symbol

When MacFORTH is waiting for text from the keyboard, a flashing cursor is displayed at the point where the text will be placed. The flash rate is set via the control panel.

Any character font may be used as the cursor. The variable **CURSOR.CHAR** contains the font# in the first 16 bits and the character in the second 16 bits. For example:

```
HEX   5F  CURSOR.CHAR  !  DECIMAL
```

sets the cursor to the default underline cursor.

```
BL  CURSOR.CHAR  !
```

sets the cursor to blank (invisible)

```
HEX  7C  CURSOR.CHAR ! DECIMAL
```

sets the cursor to a vertical bar (as in MacWrite) and

```
HEX  070041  CURSOR.CHAR  !  DECIMAL
```

sets the cursor to character 41 (A) of font#7.

Changing the cursor symbol is a good way of alerting the user when the system is in some special mode. Some of the different character cursors we have experimented with are listed below:

Hex Value	Symbol
11	command key symbol (⌘)
12	checkmark
13	diamond
14	solid apple
C6	triangle
B0	infinity symbol
BD	omega

Cutting and Pasting Between Applications

One of the more innovative features of the Macintosh is its ability to cut and paste between applications. This is done utilizing a facility known as the Desk Scrap. The Desk Scrap is maintained by the Toolbox Desk Manager. MacFORTH currently supports two types of scrap entries: TEXT and PICT.

MacFORTH Level 1 supports cutting and pasting of text data between the text editor and the desk accessories, or other applications. This is built in to the editor and explained in the Program Editing chapter. Unless you need to handle text larger than fits on a block of source code, you don't need to concern yourself with the desk scrap.

Accessing the Scrap

The following words are available for accessing the desk scrap (refer to their definitions in the glossary for more information on each):

```
    SCRAP.LEN       SCRAP.HANDLE      SCRAP.COUNTER
    ZERO.SCRAP      GET.SCRAP         PUT.SCRAP
    UNLOAD.SCRAP    LOAD.SCRAP        "TEXT
    "PICT
```

The text editor source code is a good example of accessing the desk scrap. Refer to the source code in the "Editor Blocks" file.

Macintosh Toolbox Interface

This section documents the facilities to directly call routines in the Macintosh toolbox from high level MacFORTH.

Pre-requisites

The objective of this section is neither to document the contents of the Macintosh toolbox, nor explain the interworkings of Mac/Lisa Pascal. To gain insight into those areas you need to obtain a copy of "Inside Macintosh."

As a minimum, you will need to read and understand the "Programming Macintosh Applications in Assembly Language" section of the manual. Add to this any parts of the toolbox that you want to access.

Review of Pascal Data Types

The following data types are used throughout:

Boolean:	16-bit word with LS bit set in the high order byte to indicate true or false (true = 1)
Byte:	16-bit word with byte in LS 8 bits
Char:	same as Byte
Integer:	16-bit word
Long Integer:	32-bit word
Pointer:	32-bit address
Handle:	32-bit pointer to an address which contains a 32-bit pointer

Toolbox Traps

Macintosh toolbox traps occur in 3 areas:

OS Traps: All OS traps uniformly expect an I/O buffer pointer in A0 and return an I/O result in D0. The MacFORTH defining word **OS.TRAP** creates a new word, which when later executed, pops the top item of the stack into A0, executes the trap, saves the result in the user variable **IO-RESULT**, and then executes **NEXT**. OS traps are defined in the following form:

```
HEX
A002 OS.TRAP READ        ( buf ptr -- )
A102 OS.TRAP ASYNC.READ  ( buf ptr -- )
DECIMAL
```

and may be used in the form:

```
1 >FCB  READ  ?FILE.ERROR
```

(Refer to the File System chapter for details on each command.)

Pascal Procedures: Pascal procedures are a little more complicated. There may be more than one argument passed and they may be of jumbled data types (16-bit values, including booleans, bytes, or words intermixed with 32-bit values). Fortunately, the majority of toolbox procedures either expect all 32-bit items or only the last one or two items are 16-bit values.

Uniform 32-Bit Procedure Calls: Because MacFORTH works with 32-bit stack data, Pascal procedures which expect 32-bit arguments may be easily defined with **MT**. For example:

```
            HEX  A915 MT HIDE.WINDOW ( wptr -- )  DECIMAL
```

When **HIDE.WINDOW** is executed, the trap A915 (hex) is executed with wptr on the stack.

Note: When passing parameters to Pascal procedures, just leave them on the stack in the order described in the Apple documentation (left is deepest stack item).

Procedure Call with 1 16-bit Item on the Top of the Stack: Enough of these exist to warrant a special operator.:

```
            HEX  A9C8 W>MT SYSBEEP  ( duration )  DECIMAL
```

This operator works for all cases in which all arguments below the top of the stack (if any) are 32-bits.

Procedure Call with 2 16-bit Items on the Top of the Stack: Enough of these exist to warrant a special operator:

```
            HEX  A893 2W>MT (LINE.TO)  ( x\y -- )  DECIMAL
```

Note: The trap values shown differ from those in the Apple documentation (ie. ADC8 for SysBeep, AC93 for LineTo, etc.). The 11th bit set in the Apple documentaion is an artifact of a prior generation Pascal compiler. Don't ask why, just use the correct lower value. It's what the new compiler uses.

Pascal Functions: Unfortunately, Pascal functions expect space reserved to return the result under any passed arguments. This means we have to pop off all of our arguments, push space into the stack for the returned result, and the push back the arguments. This is further complicated by the fact that the result may be either 16 or 32-bits in length. As you may have guessed, some of your favorite toolbox traps (like **NEW.WINDOW** which takes 9 parameters!!) are function calls.

MacFORTH provides toolbox trap defining words for simple function calls. For more complex calls, you'll either have to include a zero in your argument list (to reserve space for the result), or write in with the Level 2 MacFORTH 68000 assembler. The following function traps are supported:

FUNC>W	returns a 16-bit result (eg. A861 FUNC>W RANDOM)
FUNC>L	returns a 32-bit result
W>FUNC>L	16-bit parameter, 32-bit result
L>FUNC>L	32-bit parameter, 32-bit result
L>FUNC>W	32-bit parameter, 16-bit result

Complex Sound Generation

MacFORTH provides access to the Macintosh OS sound driver. The sound driver provides three different sound synthesizers:

- square wave synthesizer: produces a pre-programmed series of tones
- four tone synthesizer: produces simple harmonic tones (with up to 4 voices)
- free form synthesizer: produces complex music and speech

When the system is loaded, MacFORTH opens the device driver ".SOUND" and assigns it to its own FCB called **SOUND.FCB**. The Getting Results chapter discusses how to generate simple tones via the sound driver. For more complex sounds, you will need to create your own waveform record. For instructions on how to construct any desired free form or four-tone synthesizer record, refer to the in-depth discussion on sound generation in the Apple documentation.

A MacFORTH sound record consists of a synthesizer record proceded by a 16-bit word containing the length of the following synthesizer record. Two operators are available to play your synthesizer record:

PLAY sound record address --
Plays the desired synthesizer record, hangs the cpu until it finishes.

APLAY sound record address --
Asynchronously plays the desired synthesizer record. The processor continues execution and the sound is generated concurrently.

Refer to the source code of the demos for examples of how to define you own music using the square wave synthesizer.

Chapter 12 : MacFORTH Error Handling

This section discusses the method MacFORTH uses to handle errors. The topics discussed in this section are:

Overview

By default, when MacFORTH encounters an error condition, an error message is displayed, the current operation is aborted, and control is returned to the system window. Error conditions occur in the following categories:

- Interpreter
- Compiler
- Utility
- File
- Processor

You can override any default exception error handler. All of the messages in the preceding sections are listed in alphabetical order in the back of this section with accompanying text discussing the probable cause of the error and what action to take.

The errors supplied by the Macintosh that are specific to file handling are listed in Appendix B of the File System chapter.

Compiler and Interpreter Errors

Compiler and interpreter errors can be divided as follows:

<u>Interpreter Errors</u>

- ?
- STACK EMPTY
- MISSING STRING DELIMITER
- DECLARE VOCABULARY
- MISSING IFEND OR OTHERWISE

<u>Compiler Errors</u>

- ?
- COMPILATION ONLY, USE IN A DEFINITION
- CONDITIONALS NOT PAIRED
- DEFINITION INCOMPLETE
- DICTIONARY FULL
- EXECUTION ONLY
- MISSING STRING DELIMITER
- ATTEMPTED TO REDEFINE NULL

Because these errors are more pertinent to the program development process rather than run time applications, they are defined with the word ERROR" . An example of ERROR" is

```
        0 <  ERROR"  Illegal Argument"
```

If the value of the stack is non-zero, the console buzzer is sounded (if the QUIET option is ON), a carriage return is output followed by the most recently interpreted word and the error message. If the error occurs while interpreting text from disc, the screen# and offset are placed in the user variables SCR and R# . When you enter the editor the cursor will positioned immediately after the error.

Processor Exceptions

```
ADDRESS ERROR TRAP AT XXXXXX
BUS ERROR TRAP AT XXXXXX
ILLEGAL INSTRUCTION TRAP !
OVERFLOW TRAP !
ZERO DIVIDE TRAP !
```

These errors are defined with the word ABORT" . An example of ABORT" is

```
  0= ABORT"  Illegal Argument"
```

If the value on the top of the stack is non-zero, and no user supplied recovery stack frame has been established (discussed in next section), the default error handler outputs the message text and executes ABORT to return control to the console. While the default handler works well in the normal program development process, you will often choose to supply your own error handlers to recover from device errors and processor exceptions in actual applications.

MacFORTH Default Error Message Summary

When a system error is encountered, the MacFORTH system stops and outputs an error message. All system error messages and a discussion of their probable cause is provided below.

File I/O errors are discussed separately in the File System chapter.

Message	Probable Cause
<string> ?	The text interpreter was unable to find <string> in the CONTEXT or TRUNK vocabularies and was unable to convert it to a number. Probably a typo or the word has not been loaded.
ABORTED FROM KEYBOARD	A keyboard abort event occurred.
ADDRESS ERROR TRAP AT XXXXXXX	An attempt was made to fetch or store a 16-bit or 32-bit value at odd address XXXXXXX (displayed in hex). The 68000 hardware does not allow this. Either align the data structure on an even word boundary (using ?ALIGN) or use CMOVE.
ATTEMPED TO REDEFINE NULL	MacFORTH prevents the user from inadvertently redefining the end of line function (NULL) by typing : followed by a carriage return, as this would cause the system to respond to carriage returns in an unpredictable manner. If you truly wish to redefine the function of NULL , and understand fully the overall system impact, use the following: `: X <your definition for null> ;` `HEX A020 TOKEN.FOR X NFA W!`
BUS ERROR TRAP AT XXXXXXX	An attempt was made to access data at address XXXXXXX which is invalid. Neither memory nor hardware is capable of responding at the address.
CANNOT CLOSE SYSTEM WINDOW !	While it is possible to hide the MacFORTH window, you cannot close it.

Message	Probable Cause

CANNOT LOAD BLOCK 0 !

Block 0 of each file is reserved for data or comments. You are unable to load it. Use a higher block number.

COMPILATION ONLY USE IN A DEFINITION !

The offending word was encountered in execution state. The word is a compiler primitive and has no meaning when not compiling (ie: DO IF LOOP BEGIN).

CONDITIONALS NOT PAIRED

The text interpreter expects all conditionals to be properly nested. A terminating conditional (THEN , UNTIL , REPEAT , AGAIN , LOOP , +LOOP) was encountered for which there was not a corresponding acceptable initializing conditional (IF, ELSE, DO , BEGIN , WHILE) at the correct nesting level.

DEFINITION INCOMPLETE !

The stack depth changed inside a colon definition. This is normally the result of an unpaired conditional (ie: a missing THEN). It may however, result from using a literal inside a definition to compile a literal value that was left on the stack prior to defining a word. In this case modify the user variable CSP to indicate the difference, ie: one item dropped from the stack requires

```
[ 4 CSP +! ]
```

Warning: Conditionals leave various information (address, conditional type) on the stack at run time. Be aware of this when placing literals inside colon definitions.

DICTIONARY FULL !

Less than 260 (decimal) bytes exist in the object dictionary. If allowed to continue, scratch pad buffers above dictionary could overwrite the end of the object space. FORGET to free up dictionary space or resize the object area.

EXECUTION ONLY !

The offending word may not occur while compiling.

FILE ERROR # ___

An unidentified file error occurred. Refer to the File System chapter for identified file errors.

<u>Message</u>	<u>Probable Cause</u>
FILE NOT OPEN !	An attempt was made to access a file that was not open. Open the file and continue.
FIXED RECORD LENGTH = 0 !	FORTH blocks are merely fixed length records within a file. In order to access them, the record length for the file must be 1024. You probably attempted to read a text file as blocks.
ILLEGAL FILE NUMBER !	MacFORTH file numbers range between 0 and 9, any other value is illegal. Check the order of your operands.
ILLEGAL INSTRUCTION TRAP!	The 68000 attempted to execute an invalid (unrecognizable) instruction probably due to accidentally overwriting the dictionary. Try to locate erroneous code which overwrites dictionary.
ILLEGAL RECOVERY ATTEMPTED !	An Attempt was made to recover from an error condition with no ON.ERROR recovery handler posted.
ILLEGAL VOLUME !	The MacFORTH DIR command expects either a drive name (internal or external) or a volume reference number to produce a directory.
ISN'T UNIQUE	A word was created in the dictionary which is not unique in the CURRENT , CONTEXT , or TRUNK vocabularies and the UNIQUE.MSG switch is on. The most recent definition will be used for future references. The prior definition probably cannot be found. This warning message may be disabled when loading production code by: `UNIQUE.MSG OFF`
MISSING (STRING DELIMITER !	The input stream was exhausted (null encountered) before a delimiting right paren was found. See the MISSING STRING DELIMITER error message also.

Message   Probable Cause

MISSING { STRING DELIMITER

The input stream was exhausted (null encountered) before a delimiting right brace was found. See the MISSING STRING DELIMITER error message also.

MISSING IFEND OR OTHERWISE

MacFORTH does not allow IFTRUE ... OTHERWISE... IFEND... or IFTRUE...IFEND conditional compilation sequences to cross either input line or block boundaries. Reorganize your text to start and end such sequences on the same source block or input line.

MISSING STRING DELIMITER

The input stream was exhausted (null encountered) before the required delimiter was found. Delimited strings may not cross block or terminal input line boundaries. Insert trailing delimiter in source text.

NO FCB'S AVAILABLE

All FCB's were in use when the **NEXT.FCB** command was executed.

NOT A BLOCKS FILE!

An attempt was made to select a non-blocks file as the current blocks file for editing.

NOT ENOUGH STACK ITEMS !

Insufficient stack items where placed on the stack before executing the most recently entered word. MacFORTH selectively contains a few operators which provide this check. In applications code use:

X NEEDED

Where X is the number of items required to properly execute.

OBJECT DICTIONARY FULL !

Object dictionary space is full. Use ROOM and RESIZE.OBJECT to allocate more object space from the heap.

OBJECT WON'T FIT!

An attempt was made to resize the object dictionary into a memory segment which is too small.

OVERFLOW TRAP !

Default handler for exception caused by TRAPV . instruction - see Motorola documentation.

Message	Probable Cause
RANGE TRAP !	User assembly code generated a range TRAP from a CHK, instruction. See MacFORTH Level 2 Assembler documentation.
STACK EMPTY !	Text interpreter found the stack pointer greater than the top of the stack . An attempt was made to access nonexistent stack data. NOTE: There is no run-time check made by the address interpreter. When executing code underflows the stack, the contents of the text input buffer and eventually the return stack are unpredictable. A buffer zone of 2 bytes is reserved for minor underflows.
SOUND ERROR!	The sound generation driver reported an error to MacFORTH.
UNABLE TO RESIZE OBJECT !	The memory manager was unable to increase the size of the object space due to the placement of a fixed/locked memory segment immediately behind it. Refer to the Advanced Topics chapter for a discussion of memory allocation and resizing.
UNABLE TO RESIZE VOCABULARY !	The memory manager was unable to increase the size of the vocabulary space due to the placement of a fixed/locked memory segment immediately behind it. Refer to the Advanced Topics chapter for a discussion of memory allocation and resizing.
VOCABULARY FULL !	The current vocabulary is full. Use RESIZE.VOCAB to allocate more vocabulary space. ROOM displays current allocation. Refer to the Advanced Topics chapter for more information on memory allocation.
VOCABULARY WON'T FIT!	An attempt was made to resize the vocabulary into a memory segment which is too small.
WARNING: Disc full at block #____	ADD.BLOCKS encountered an end of volume condition. No more space exists on the disk. All available space is allocated.
ZERO DIVIDE TRAP !	The 68000 attempted to divide by zero in hardware.

CHAPTER 13: MacFORTH Glossary

This chapter is broken down into three parts:

1.) An ASCII sorted index to each word in the glossary (with the page number the word's definition is on) for quick reference. For finding a word which starts with a special ASCII character (like ! or ") you will probably find it easier to look it up in this index to find which page it is on (instead of flipping through the glossary itself).

2.) A listing of the words by category. We have broken down the words in the system and organized them into groups for your convenience. This is helpful when you are working with a certain class of words (like Numeric Conversion) to see what other commands are available. As with the ASCII sorted index, each entry gives the page number in the glossary where the definition is found.

3.) All MacFORTH system words sorted in ASCII ascending sequence, with their stack contents and a description of the action of the word.

We have spent a great deal of time putting this glossary together so it is easy to use and understand. In order to get the most out of your MacFORTH system, we recommend that you read through the entire glossary (yes, from start to finish) to get an idea of the wide range of capabilities that are available.

Glossary Key

The following symbols are used in the glossary to indicate the contents of the parameter stack before and after execution of the particular word:

Symbol	Meaning
$	Prefix used to indicate a string field operation. By itself, it indicates a string address. As a prefix to cnt ($cnt) it indicates a string field count.
addr	A memory address. A number suffix is used to differentiate between addresses.

Symbol	Meaning
bool	A boolean flag. A value of zero indicates a false flag; non-zero indicates true. MacFORTH words which return pure boolean results use -1 as a true flag (all bits set).
char	An 8-bit character value.
cnt	A count value. Usually used with an addr symbol to designate the starting address and count for an array of string value. Also used to designate the width of a field.
dest	Refers to a destination address.
false	A boolean false flag (0).
fcb	A file control block address.
file#	A valid file number (0-8) referring to a file.
file$	The string address of a file name.
flag	A special flag value. The specific meanings for different flag values are discussed in the text of the definitions for the word which uses the flag.
n or un	A 32-bit integer. A number suffix is used to differentiate between numbers. The prefix u indicates the number is unsigned.
pos mode	The positioning mode used for file system operations (ie. FROM.START).
src	Refers to a source address.

Symbol	Meaning
true	A boolean true flag (-1).
w	A 16-bit integer. A number suffix is used to differentiate between numbers.
wptr	Refers to the pointer to a window which contains all of the information about the window needed by the system. This value is returned by a window specifier (its name).
\	Delimits items on the stack. It is pronounced "under". For example, n1\n2 -- addr is read "n1 under n2 leaves addr" .
[...] or [...]	Indicates different possible stack outcomes. For example, the word ?DUP duplicates the top item on the stack if it is non-zero. It's stack notation is n -- [n\n] or [n] Indicating an integer is expected on the stack and leaving either two items (n under n) or the original integer itself.

In some of the definitions, we have used a more mnemonic name for a parameter instead of a standard symbol for clarity. For example, "index" is used to indicate an index value, "token" refers to the token of a word, "blk#" refers to a block number, and so on.

Always refer to the text of the definition for a more complete explanation of the required parameters.

Glossary Size

Most FORTH glossaries are noted for their small size (typically less than 250 items). The MacFORTH glossary contains about 900 entries. This is due to the extensive access to the Macintosh toolbox provided by MacFORTH.

ASCII (Alphabetic) MacFORTH Glossary Index

The following list sorts the MacFORTH Glossary entries in ASCII sequence. Each word is listed in ASCII order with the page number (in the glossary) that its description is found.

Page#	Word
30	!
	!CSP
	!PENSTATE
	!POINT
	!RECT
	!SR
	"
	"BLKS
31	"DATA
	"M4TH
	"PICT
	"TEXT
	#
	#>
	#FILES
	#FIND
	#S
32	$ADDR
	$LIT
	'
	'INTERPRET
	(
	(!ON.ACTIVATE)
33	(!ON.UPDATE)
	($LIT)
	((ABORT))
	((ERROR))
	(+LOOP)
	(.")
	(.S)
34	(;CODE@)
	(>CODE)
	(ABORT")
	(ABORT)
	(DO)
	(ERROR")
	(ERROR)
35	(EXCPT)
	(FIND)
	(GET)
	(GET.FILE)
	(LINE)
	(LINE.TO)
	(LOOP)
	(MENU.SELECTION:)
36	(MOVE)
	(MOVE.TO)
	(OF)
	(ON.ERROR)
	(PENSIZE)
	(PUT.FILE)
	(R/W)
	(TEXTSIZE)
	(TRACE)
37	(TRACK.CONTROL)
	(WORD)
	)CONSTANT
	)U
	*
	*/
	*/MOD
38	+
	+!
	+CARTESIAN
	+FIND
	+FOLLOWER
	+HBAR
39	+LOAD
	+LOOP
	+MAX.BLK#
	+ON.ACTIVATE
	+ON.UPDATE
	+POINT
	+PRINTER
40	+REC.SIZE
	+SCR#
	+THRU
	+TVISRECT
	+VBAR
	+W.ATTRIBUTES
	+W.BEHIND
41	+W.LINK
	+W.TYPE
	+WBOUNDS
	+WCBOUNDS
	+WFILE.PTR
	+WLINE.HEIGHT
	+WREFCON
	+WTITLE
42	+XYBIAS
	+XYOFFSET
	+XYPIVOT
	+XYPOS
	+XYSCALE
	,
	,"
	-
43	-->
	-1
	-2
	-3
	-4
	-FIND
	-FOUND
	-KEYBOARD
	-LATEST
44	-NULL
	-POINT

Page*	Word	Page*	Word	Page*	Word
44	-STRING		2DUP		>W@<
	-TEXT		2OVER		?
	-TRAILING		2SWAP		?ALIGN
	.		2W>MT		?BLOCKS.FILE
	."		3		?COMP
45	.ABORT		3+		?CSP
	.DATE$		3-		?DAYS
	.FILE.ERROR		4		?DOUBLE.CLICK
	.R		4*		?DUP
	.S		4+	53	?EOF
	.TIME$		4-		?EVENT
	.TYPE		4/		?EXEC
	/	49	5+		?FILE.ERROR
46	/MOD		5-		?FILES
	0		6+		?HEAP.SIZE
	0<		6-		?IN.CONTROL
	0=		7+		?KEYSTROKE
	0>		7-		?LOADING
	0BRANCH		8*	54	?OPEN
	0MAX		8+		?PAIRS
	1		8-		?PUNCT
	1+		8/		?ROOM
	1-	50	:		?SECONDS
	10+		;		?SOUND
	10-		<		?STACK
47	12HOURS		<*		?TERMINAL
	16*		<W@		?TRACE
	16+		=	55	?WORD
	16-		=CELLS		@
	16/		=DROP		@@
	1DAY	51	>		@CLOCK
	1HOUR		>.FILE.ERROR<		@EVENT
	2		>FCB		@FILE.NAME
	2!		>IN		@INIT
	2*		>JSR		@MOUSE
	2+		>LIST<		@MOUSE.DN
	2-		>R	56	@MOUSEXY
	2/		>RECT		@PEN
	2@		>SYS.WINDOW		@PENSTATE
48	2DROP	52	>W!<		@POINT

Page#	Word	Page#	Word	Page#	Word
56	@RECT		BRING.TO.FRONT		CREATE.FILE
	@SR		BS	65	CALF
	ABORT		BUFFER		CSP
	ABORT"		BYE		CURRENT
	ABORT.EVENT	61	C!		CURRENT-FILE
57	ABS		C,		CURRENT.POSITION
	ACTIVATE.EVENT		C/L		CURSOR
	ADD.BLOCKS		C@		CURSOR.CHAR
	ADD.CONTROL		CARTESIAN		DAYS>
	ADD.RES.MENU		CASE		DEALLOT
	ADD.WINDOW		CENTER		DEBUG
	AGAIN		CHARWIDTH	66	DEBUG.ONLY
	ALIT		CHECK.BOX		DECIMAL
	ALLOCATE	62	CIRCLE		DEFAULT.ACTIVATE
58	ALLOT		CLEAR		DEFINITIONS
	AND		CLIP>CONTENT		DELETE
	APLAY		CLOSE		DELETE.BLOCKS
	APPEND		CLOSE.ALL		DELETE.MENU
	APPEND.BLOCKS		CLOSE.BOX		DEPTH
	APPEND.ITEMS		CLOSE.WINDOW		DEVICE.CONTROL
	APPLE.MENU		CMOVE		DEVICE.STATUS
	ARC		CMOVE>	67	DFLT.CONTROL
	ASSIGN		CNT		DFLT.WINDOW.TAIL
	AUTO.KEY	63	CNTR		DIGIT
59	AXE		COL		DIR
	B/BUF		COMMAND.KEY		DIRECTORY
	BACK		COMPILE		DISCARD.UPDATES
	BACKPAT		COMPILING		DISK
	BASE		CONDENSED		DISK.EVENT
	BEGIN		CONFIGURE.PRINTER		DISPOSE.CONTROL
	BHEAD		CONSOLE		DKGRAY
	BL		CONSTANT	68	DO
	BLACK	64	CONTEXT		DO.EVENTS
60	BLANKS		CONVERT		DOES>
	BLK		COPY		DOT
	BLOCK		COS		DOWN.BUTTON
	BLOCK-FILE		COUNT		DP
	BOLD		CR		DPL
	BOOLEAN		CREATE	69	DRAW.CHAR
	BRANCH		CREATE.BLOCKS.FILE		DRAW.CONTROLS

Page#	Word	Page#	Word	Page#	Word
69	DRAW.MENU.BAR		FLUSH		GINIT
	DRAW.TO		FLUSH.EVENTS		GLOBAL>LOCAL
	DRAWSTRING		FLUSH.FILE		GRAY
	DROP		FLUSH.VOL	79	HANDLE.SIZE
	DRVR.EVENT	75	FMT.DATE$		HANDLER
	DUP		FMT.TIME$		HBAR.BOUNDS
	DUP>R		FOLLOWER		HERE
	EJECT		FORGET		HEX
70	ELSE		FORTH		HIDE.CURSOR
	EMIT		FRAME		HIDE.PEN
	EMPTY		FROM.CURRENT		HIDE.WINDOW
	EMPTY-BUFFERS		FROM.END		HILITE.CONTROL
	ENCLOSE	76	FROM.HEAP		HILITE.MENU
	ENDCASE		FROM.START	80	HILITE.WINDOW
71	ENDOF		FRONT.WINDOW		HLD
	ENTER.FLAG		FUNC>L		HOLD
	ERASE		FUNC>W		HUSH
	ERASE.RECT		GET		I
	ERROR		GET.CONTROL		I!
	ERROR"		GET.CURSOR		I+
	EVENT.LOOP		GET.DATE$		I+!
72	EVENT.RECORD		GET.EOF		I+@
	EVENT.TABLE	77	GET.FILE.INFO		I+W!
	EVENTS		GET.FILE.TYPE		I+W@
	EXECUTE		GET.ICON	81	I-
	EXIT		GET.ITEM		I@
	EXPECT		GET.LINE.HEIGHT		IBEAM
	EXTENDED		GET.PICTURE		IC!
73	EXTERNAL		GET.PIXEL		IC@
	FALSE		GET.REC.LEN		ID.
	FCB.LEN		GET.SCRAP		IF
	FENCE		GET.TEXTFONT		IFEND
	FIELD		GET.TEXTMODE	82	IFTRUE
	FILE.ERROR.MSGS	78	GET.TEXTSIZE		ILLEGAL.FILE
	FILE.TYPE		GET.TEXTSTYLE		IMMEDIATE
	FILL		GET.TIME$		IN.BUTTON
	FIND		GET.WINDOW		IN.CHECKBOX
74	FIND.CONTROL		GET.XYOFFSET		IN.CLOSE.BOX
	FIND.WINDOW		GET.XYPIVOT		IN.DESKTOP
	FIRST		GET.XYSCALE		IN.DRAG.BOX

Page#	Word	Page#	Word	Page#	Word
95	OFFSET		PLOT.ICON		RECOVER
	ON		PNTR		RECOVER.HANDLE
	ON.ACTIVATE		POCKET	104	RECT
96	ON.CONTROL		POINT		RECTANGLE
	ON.ERROR		POINT>XY		REG.SET
	ON.UPDATE	100	POLYGON		REGION
	OPEN		POSITION.FIXED		RELEASE
	OPEN"		POST.EVENT		REMOVE
	OPEN.DA		PREV		RENAME
	OPEN.DEVICE		PRINT		REPEAT
	OPEN.PORT		PRINT.BITS		RESIZE.HANDLE
	OPEN.PRINTER		PRINT.FCB		RESIZE.OBJECT
	OPEN.RSRC		PRINT.SCREEN	105	RESIZE.VOCAB
97	OPEN.SOUND		PRINT.WINDOW		RESUME
	OPTIONS.MENU		PRINTER		RETRY
	OR	101	PRINTER.ONLY		REWIND
	OS.TRAP		PTINRECT		RMOVE
	OTHERWISE		PURGE.MENUBAR		ROLL
	OUTLINE		PURGE.WINDOWS		ROOM
	OVAL		PURGABLE		ROT
	OVER		PUSH.BUTTON	106	RP!
	PAD		PUT.SCRAP		RP@
	PAGE		QUERY		RRECTANGLE
	PAGE.DOWN		QUIET		RSRVMEM
98	PAGE.UP		QUIT		RST.PRINTER
	PAINT	102	R#		S0
	PATBIC		R/W		SAVE-BUFFERS
	PATCOPY		R0		SCALE
	PATOR		R>		SCALE>XY
	PATTERN		R>DROP		SCALE>Y
	PATXOR		R@	107	SCAN.FROM
	PAUSE		RADIO.BUTTON		SCR
	PEN.NORMAL		RANDOM		SCRAP.COUNTER
	PENMODE		RANGE		SCRAP.HANDLE
99	PENPAT	103	RANGE.OF		SCRAP.LEN
	PENSIZE		RDRAW		SCRATCH
	PFA		READ.FIXED		SCREEN.BITS
	PICK		READ.TEXT		SCREEN.BOUNDS
	PLAIN		READ.VIRTUAL		SCROLL
	PLAY		REAL.FONT?		SCROLL.LEFT/RIGHT

Page#	Word	Page#	Word	Page#	Word
107	SCROLL.UP		SRCXOR		TEXTSIZE
	SCROLL.UP/DOWN		STACK.ERROR		TEXTSTYLE
108	SEED		START.FLAG	115	THEN
	SELECT		STATE		THIS.CONTROL
	SELECT.WINDOW		STATUS		THIS.PART
	SEND.BEHIND		STILL.DOWN		THRU
	SET.CONTROL		STRINGWIDTH		TIB
	SET.CONTROL.MAX		SWAP		TICKCOUNT
	SET.CONTROL.MIN	112	SYS.FILE		TO.HEAP
	SET.CONTROL.RANGE		SYS.WINDOW		TOGGLE
	SET.CURSOR		SYSBEEP		TOGGLE.CONTROL
	SET.EOF		SYSPARMS		TOKEN.FOR
	SET.FENCE		SYSTEM.EDIT		TOKEN>ADDR
	SET.FILE.INFO		TAB.STOPS	116	TONE
109	SET.ITEM$		TEACTIVATE		TRACE
	SET.ORIGIN		TECALTEXT		TRACE.TOKEN
	SET.REC.LEN		TECLICK		TRACK.CONTROL
	SET.STRING		TECOPY		TRIAD
	SET.WTITLE		TECUT		TRUE
	SETUP.SERIAL		TEDEACTIVATE		TRUNK
	SHADOW		TEDELETE		TRY
	SHOW	113	TEDISPOSE		TYPE
	SHOW.CONTROLS		TEIDLE		UNDERLINE
	SHOW.CURSOR		TEINSERT	117	UNIQUE.MSG
	SHOW.PEN		TEKEY		UNLOAD.SCRAP
110	SHOW.WINDOW		TENEW		UNLOCK.FILE
	SIGN		TEPASTE		UNLOCK.HANDLE
	SIN		TERECORD		UNTIL
	SIZE.BOX		TESCROLL		UP.BUTTON
	SIZE.WINDOW		TESET.JUST		UPDATE
	SMUDGE		TESET.SELECT		UPDATE.EVENT
	SOUND.FCB		TESET.TEXT		UPPER
	SP!		TEST.CONTROL	118	UPPER.LEFT
	SP@		TEUPDATE		USE
	SPACE		TEXT.BOX		USE"
	SPACES	114	TEXT.CLICK		USER
111	SQRT		TEXT.FIELD		VARIABLE
	SRCBIC		TEXT.RECORD		VBAR.BOUNDS
	SRCCOPY		TEXTFONT		VECTOR
	SRCOR		TEXTMODE		VERSION

Page#	Word
118	VERSION#
	VIRTUAL
119	VOCABULARY
	W!
	W*
	W,
	W.ATTRIBUTES
	W.BEHIND
	W.BOUNDS
	W.LINKAGE
120	W.TITLE
	W.TYPE
	W/
	W/MOD
	W>FUNC>L
	W>MT
	W@
	WAIT
	WAIT.MOUSE.UP
	WATCH
	WCONSTANT
121	WHILE
	WHITE
	WINDOW
	WLIT
	WMOD
	WORD
122	WORDS
	WRITE.FIXED
	WRITE.TEXT
	WRITE.VIRTUAL
	XEXPECT
	XLATE
	XOR
	XY><TLBR
	XY>POINT
	XYAXIS
123	XYOFFSET
	XYPIVOT
	XYSCALE

Page#	Word
123	ZERO.SCRAP
	[
	[COMPILE]
	]
	{

MacFORTH Glossary Index by Subject

This index lists the words in the MacFORTH glossary into the following logical groups:

1.) Stack Manipulation	13.) Menus
2.) Comparison	14.) Windows
3.) Arithmetic and Logical	15.) Graphics
4.) Memory	16.) String Manipulation
5.) Control Structures	17.) User Interface
6.) Console Input/Output	18.) Machine Interface
7.) Numeric Conversion	19.) Trace and Debug
8.) Mass Storage	20.) Printer and Serial
9.) Vocabularies and Dictionary Management	21.) Event Related
10.) Compiler	22.) Misc. Constants
11.) Toolbox Interface	23.) Sound Driver
12.) Error Handling	24.) Misc. Toolbox Words

1. Stack Manipulation:

Word	Page#	Word	Page#
2DROP	(48)	R>	(102)
2DUP	(48)	R>DROP	(102)
2OVER	(48)	R@	(102)
2SWAP	(48)	ROLL	(105)
=DROP	(50)	ROT	(105)
>R	(51)	RP!	(106)
>RECT	(51)	RP@	(106)
?DUP	(52)	S0	(106)
DROP	(69)	SP!	(110)
DUP	(69)	SP@	(110)
DUP>R	(69)	SWAP	(111)
OVER	(97)		
PICK	(99)		
R0	(102)		

2. Comparison:

Word	Page#	Word	Page#
-STRING	(44)	<	(50)
0<	(46)	=	(50)
0=	(46)	>	(51)
0>	(46)	RANGE	(102)

3. Arithmetic and Logical:

Word	Page#	Word	Page#
*	(37)	7+	(49)
*/	(37)	7-	(49)
*/MOD	(37)	8*	(49)
+	(38)	8+	(49)
-	(42)	8-	(49)
/	(45)	8/	(49)
/MOD	(46)	=CELLS	(50)
0MAX	(46)	ABS	(57)
1+	(46)	AND	(58)
1-	(46)	BOOLEAN	(60)
10+	(46)	COS	(64)
10-	(46)	FALSE	(73)
16*	(47)	M*	(88)
16+	(47)	M/MOD	(88)
16-	(47)	MAX	(89)
16/	(47)	MIN	(90)
2*	(47)	MOD	(90)
2+	(47)	NEGATE	(92)
2-	(47)	NOT	(93)
2/	(47)	OR	(97)
3+	(48)	RANDOM	(102)
3-	(48)	TRUE	(116)
4*	(48)	W/	(120)
4+	(48)	W/MOD	(120)
4-	(48)	WMOD	(121)
4/	(48)	XOR	(122)
5+	(49)		
5-	(49)		
6+	(49)		
6-	(49)		

4. Memory:

Word	Page*	Word	Page*
!	(30)	IC@	(81)
)CONSTANT	(37)	IN.HEAP	(83)
)U	(37)	LMOVE	(87)
+!	(38)	LMOVE>	(87)
+FOLLOWER	(38)	LOCK.FONT	(88)
2!	(47)	LOCK.HANDLE	(88)
2@	(47)	NON.PURGABLE	(93)
<W@	(50)	OFF	(95)
>W!<	(52)	ON	(95)
>W@<	(52)	PURGABLE	(101)
?HEAP.SIZE	(53)	RECOVER.HANDLE	(103)
@	(55)	RESIZE.HANDLE	(104)
@@	(55)	RRECTANGLE	(106)
@CLOCK	(55)	RSRVMEM	(106)
C!	(61)	TO.HEAP	(115)
C@	(61)	TOGGLE	(115)
FROM.HEAP	(76)	UNLOCK.HANDLE	(117)
HANDLE.SIZE	(79)	W!	(119)
I!	(80)	W*	(119)
I+	(80)	W@	(120)
I+!	(80)		
I+@	(80)		
I+W!	(80)		
I+W@	(80)		
I-	(81)		
I@	(81)		
IC!	(81)		

5. Control Structures:

Word	Page#	Word	Page#
(+LOOP)	(33)	I	(80)
(DO)	(34)	IF	(81)
(LOOP)	(35)	IFEND	(81)
(OF)	(36)	IFTRUE	(82)
+LOOP	(39)	J	(85)
0BRANCH	(46)	LEAVE	(86)
AGAIN	(57)	LOOP	(88)
BACK	(59)	OF	(95)
BEGIN	(59)	OTHERWISE	(97)
BRANCH	(60)	RANGE.OF	(103)
CASE	(61)	REPEAT	(104)
DO	(68)	THEN	(115)
ELSE	(70)	UNTIL	(117)
ENDCASE	(70)	WHILE	(121)
ENDOF	(71)		
EXIT	(72)		

6. Console Input/Output:

Word	Page#	Word	Page#
.TYPE	(45)	MAC.CON	(89)
?KEYSTROKE	(53)	MAC.CONSOLE	(89)
?TERMINAL	(54)	NO.ECHO	(93)
CNT	(62)	PAGE	(97)
CNTR	(63)	PNTR	(99)
COL	(63)	QUERY	(101)
CONSOLE	(63)	SCROLL	(107)
CR	(64)	SCROLL.UP	(107)
CURSOR.CHAR	(65)	SPACE	(110)
DFLT.CONTROL	(67)	SPACES	(110)
EMIT	(70)	TAB.STOPS	(112)
ENTER.FLAG	(71)	TYPE	(116)
EXPECT	(72)	XEXPECT	(122)
KEY	(85)		
LINE#	(86)		

7. Numeric Conversion:

Word	Page#	Word	Page#
#>	(31)	FMT.DATE$	(75)
#S	(31)	FMT.TIME$	(75)
.	(44)	GET.DATE$	(76)
.DATE$	(45)	GET.TIME$	(78)
.R	(45)	HEX	(79)
.TIME$	(45)	HLD	(80)
<#	(50)	HOLD	(80)
?	(52)	MONTHS	(90)
?DAYS	(52)	NUMBER	(94)
?PUNCT	(54)	SEED	(100)
?SECONDS	(54)	SIGN	(110)
BASE	(59)	SIN	(110)
CONVERT	(64)	SQRT	(111)
DAYS>	(65)	TICKCOUNT	(115)
DECIMAL	(66)		
DIGIT	(67)		
DPL	(68)		
ENCLOSE	(70)		

8. Mass Storage:

Word	Page#	Word	Page#
#FILES	(31)	?OPEN	(54)
(GET.FILE)	(35)	@FILE.NAME	(55)
(LINE)	(35)	ADD.BLOCKS	(57)
(PUT.FILE)	(36)	ALLOCATE	(57)
(R/W)	(36)	APPEND.BLOCKS	(58)
+MAX.BLK#	(39)	ASSIGN	(58)
+REC.SIZE	(40)	BLOCK	(60)
+SCR#	(40)	BLOCK-FILE	(60)
>.FILE.ERROR<	(51)	BUFFER	(60)
>FCB	(51)	CLOSE.ALL	(62)
?BLOCKS.FILE	(52)	COPY	(64)
?EOF	(53)	CREATE.BLOCKS.FILE	(64)
?FILES	(53)		

((8. Mass Storage Continued))

Word	Page*	Word	Page*
CREATE.FILE	(64)	OPEN"	(96)
CURRENT-FILE	(65)	OPEN.RSRC	(96)
CURRENT.POSITION	(65)	POINT	(99)
DELETE	(66)	POSITION.FIXED	(100)
DELETE.BLOCKS	(66)	PREV	(100)
DISK	(67)	R/W	(102)
EJECT	(69)	READ.FIXED	(103)
EMPTY-BUFFERS	(70)	READ.TEXT	(103)
EXTERNAL	(73)	READ.VIRTUAL	(103)
FCB.LEN	(73)	REMOVE	(104)
FILE.ERROR.MSGS	(73)	RENAME	(104)
FILE.TYPE	(73)	REWIND	(105)
FIRST	(74)	SAVE-BUFFERS	(106)
FLUSH	(74)	SELECT	(108)
FLUSH.FILE	(74)	SET.EOF	(108)
FLUSH.VOL	(74)	SET.FILE.INFO	(108)
FROM.CURRENT	(75)	SET.REC.LEN	(109)
FROM.END	(75)	SYS.FILE	(112)
FROM.START	(76)	UNLOCK.FILE	(117)
GET.EOF	(76)	UPDATE	(117)
GET.FILE.INFO	(77)	USE	(118)
GET.FILE.TYPE	(77)	USE"	(118)
GET.ICON	(77)	VIRTUAL	(118)
GET.PICTURE	(77)	WRITE.FIXED	(122)
GET.REC.LEN	(77)	WRITE.TEXT	(122)
ILLEGAL.FILE	(82)	WRITE.VIRTUAL	(122)
INCLUDE"	(83)		
INTERNAL	(84)		
IO-RESULT	(84)		
KILL.IO	(86)		
LIMIT	(86)		
LOCK.FILE	(88)		
MAC.FILES	(89)		
MAC.R/W	(89)		
NEW.BLOCKS.FILE	(92)		
NEW.FILE	(92)		
NEXT.FCB	(93)		
OFFSET	(95)		
OPEN	(96)		

9. Vocabularies and Dictionary Management:

Word	Page*	Word	Page*
*FIND	(31)	NFA	(93)
'	(32)	OBJECT.FULL!!	(95)
(FIND)	(35)	OBJECT.HANDLE	(95)
+FIND	(38)	OBJECT.ROOM	(95)
,	(42)	PFA	(99)
,"	(42)	RESIZE.OBJECT	(104)
-FIND	(43)	RESIZE.VOCAB	(105)
-FOUND	(43)	SET.FENCE	(108)
-LATEST	(43)	TRUNK	(116)
?ALIGN	(52)	VOCABULARY	(119)
ALLOT	(58)	W,	(119)
APPEND	(58)		
AXE	(59)		
BHEAD	(59)		
C,	(61)		
CONTEXT	(64)		
CURRENT	(65)		
DEALLOT	(65)		
DEFINITIONS	(66)		
DP	(68)		
EMPTY	(70)		
FENCE	(73)		
FIND	(73)		
FORGET	(75)		
FORTH	(75)		
HERE	(79)		
LATEST	(86)		
MINIMUM.OBJECT	(90)		
MINIMUM.VOCAB	(90)		

10. Compiler:

Word	Page#	Word	Page#
!CSP	(30)	LOAD	(87)
'INTERPRET	(32)	MAKE.TOKEN	(89)
(	(32)	NEW.TOKEN	(92)
(;CODE@)	(34)	NEXT.PTR	(93)
(>CODE)	(34)	NO.FENCE	(93)
(WORD)	(37)	POCKET	(99)
+LOAD	(39)	PURGE.MENUBAR	(101)
+THRU	(40)	PURGE.WINDOWS	(101)
-->	(43)	QUIT	(101)
-NULL	(44)	SCAN.FROM	(107)
:	(50)	SMUDGE	(110)
;	(50)	STATE	(111)
>IN	(51)	THRU	(115)
?LOADING	(53)	TIB	(115)
ALIT	(57)	TOKEN.FOR	(115)
BLK	(60)	TOKEN>ADDR	(115)
COMPILE	(63)	USER	(118)
COMPILING	(63)	VARIABLE	(118)
CONSTANT	(63)	WCONSTANT	(120)
CREATE	(64)	WLIT	(121)
DOES>	(68)	WORD	(121)
EXECUTE	(72)	[	(123)
FIELD	(73)	[COMPILE]	(123)
IMMEDIATE	(82)	]	(123)
INTERPRET	(84)	{	(123)
LAST.TOKEN	(86)		
LIT	(87)		
LITERAL	(87)		

11. Toolbox Interface:

Word	Page#	Word	Page#
2W>MT	(48)	MT>W	(91)
FUNC>L	(76)	OPEN.DA	(96)
FUNC>W	(76)	OS.TRAP	(97)
L>FUNC>L	(86)	W>FUNC>L	(120)
L>FUNC>W	(86)	W>MT	(120)
MT	(91)		

12. Error Handling:

Word	Page*	Word	Page*
((ABORT))	(33)	ABORT	(56)
((ERROR))	(33)	ABORT"	(56)
(ABORT")	(34)	CSP	(65)
(ABORT)	(34)	ERROR	(71)
(ERROR")	(34)	ERROR"	(71)
(ERROR)	(34)	NO.RETRY	(93)
(EXCPT)	(35)	ON.ERROR	(96)
(ON.ERROR)	(36)	RECOVER	(103)
.ABORT	(45)	REG.SET	(104)
.FILE.ERROR	(45)	RESUME	(105)
.S	(45)	RETRY	(105)
?COMP	(52)	TRY	(116)
?CSP	(52)		
?EXEC	(53)		
?FILE.ERROR	(53)		
?PAIRS	(54)		
?STACK	(54)		

13. Menus:

Word	Page*		
(MENU.SELECTION:)	(35)	MENU.ENABLE	(90)
APPEND.ITEMS	(58)	MENU.HANDLE	(90)
DELETE.MENU	(66)	MENU.SELECTION:	(90)
DRAW.MENU.BAR	(69)	MENUS	(90)
GET.ITEM	(77)	NEW.MENU	(92)
HILITE.MENU	(79)	OPTIONS.MENU	(97)
IN.MENUBAR	(83)	SET.ITEM$	(109)
ITEM.CHECK	(84)	SYSTEM.EDIT	(112)
ITEM.ENABLE	(85)		
ITEM.ICON	(85)		
ITEM.MARK	(85)		
ITEM.STYLE	(85)		

14. Windows:

Word	Page#	Word	Page#
(!ON.ACTIVATE)	(32)	HIDE.WINDOW	(79)
(!ON.UPDATE)	(33)	HILITE.WINDOW	(80)
+HBAR	(38)	IN.CLOSE.BOX	(82)
+ON.ACTIVATE	(39)	IN.DESKTOP	(82)
+ON.UPDATE	(39)	IN.DRAG.BOX	(82)
+VBAR	(40)	IN.LOWER.WINDOW	(83)
+W.ATTRIBUTES	(40)	IN.SIZE.BOX	(83)
+W.BEHIND	(40)	IN.SYS.WINDOW	(83)
+W.LINK	(41)	INVALID.RECT	(84)
+W.TYPE	(41)	LINE.HEIGHT	(86)
+WBOUNDS	(41)	NEW.WINDOW	(92)
+WCBOUNDS	(41)	NO.CLIP	(93)
+WFILE.PTR	(41)	NOT.VISIBLE	(93)
+WLINE.HEIGHT	(41)	ON.ACTIVATE	(95)
+WREFCON	(41)	ON.UPDATE	(96)
+WTITLE	(41)	SCREEN.BOUNDS	(107)
+XYBIAS	(42)	SCROLL.LEFT/RIGHT	(107)
+XYOFFSET	(42)	SCROLL.UP/DOWN	(107)
+XYPIVOT	(42)	SELECT.WINDOW	(108)
+XYPOS	(42)	SEND.BEHIND	(108)
+XYSCALE	(42)	SET.WTITLE	(109)
>SYS.WINDOW	(51)	SHOW.CURSOR	(109)
?IN.CONTROL	(53)	SHOW.PEN	(109)
ADD.WINDOW	(57)	SHOW.WINDOW	(110)
BRING.TO.FRONT	(60)	SIZE.BOX	(110)
CHECK.BOX	(61)	SIZE.WINDOW	(110)
CLIP>CONTENT	(62)	SYS.WINDOW	(112)
CLOSE	(62)	VBAR.BOUNDS	(118)
CLOSE.BOX	(62)	W.ATTRIBUTES	(119)
CLOSE.WINDOW	(62)	W.BEHIND	(119)
DEFAULT.ACTIVATE	(66)	W.BOUNDS	(119)
DFLT.WINDOW.TAIL	(67)	W.LINKAGE	(119)
DISCARD.UPDATES	(67)	W.TITLE	(120)
FIND.CONTROL	(74)	W.TYPE	(120)
FIND.WINDOW	(74)	WINDOW	(121)
FRONT.WINDOW	(76)		
GET.WINDOW	(78)		
HBAR.BOUNDS	(79)		

15. Graphics:

Word	Page*	Word	Page*
!PENSTATE	(30)	GET.TEXTMODE	(77)
!POINT	(30)	GET.TEXTSIZE	(78)
!RECT	(30)	GET.TEXTSTYLE	(78)
(LINE.TO)	(35)	GET.XYOFFSET	(78)
(MOVE)	(36)	GET.XYPIVOT	(78)
(MOVE.TO)	(36)	GET.XYSCALE	(78)
(PENSIZE)	(36)	GINIT	(78)
(TEXTSIZE)	(36)	GLOBAL>LOCAL	(78)
+CARTESIAN	(38)	GRAY	(78)
+POINT	(39)	HIDE.CURSOR	(79)
-POINT	(44)	HIDE.PEN	(79)
@PEN	(56)	IBEAM	(81)
@PENSTATE	(56)	INIT.CURSOR	(83)
@POINT	(56)	INVERT	(84)
@RECT	(56)	ITALIC	(84)
ARC	(58)	LOCAL>GLOBAL	(88)
BACKPAT	(59)	LOWER.LEFT	(88)
BLACK	(59)	LTGRAY	(88)
BOLD	(60)	MAKE.RECT	(89)
CARTESIAN	(61)	MAX.X	(89)
CENTER	(61)	MAX.Y	(90)
CHARWIDTH	(61)	MOVE.TO	(91)
CIRCLE	(62)	NOTPATBIC	(94)
CLEAR	(62)	NOTPATCOPY	(94)
CONDENSED	(63)	NOTPATOR	(94)
CURSOR	(65)	NOTPATXOR	(94)
DKGRAY	(67)	NOTSRCBIC	(94)
DOT	(68)	NOTSRCCOPY	(94)
DRAW.CHAR	(69)	NOTSRCOR	(94)
DRAW.TO	(69)	NOTSRCXOR	(94)
DRAWSTRING	(69)	OPEN.PORT	(96)
ERASE.RECT	(71)	OUTLINE	(97)
EXTENDED	(72)	OVAL	(97)
FRAME	(75)	PAINT	(98)
GET.CURSOR	(76)	PATBIC	(98)
GET.LINE.HEIGHT	(77)	PATCOPY	(98)
GET.PIXEL	(77)	PATOR	(98)
GET.TEXTFONT	(77)	PATTERN	(98)

((15. Graphics Continued))

Word	Page#	Word	Page#
PATXOR	(98)	SHADOW	(109)
PEN.NORMAL	(98)	SRCBIC	(111)
PENMODE	(98)	SRCCOPY	(111)
PENPAT	(99)	SRCOR	(111)
PENSIZE	(99)	SRCXOR	(111)
PLAIN	(99)	STRINGWIDTH	(111)
PLOT.ICON	(99)	TEXTFONT	(114)
POINT>XY	(99)	TEXTMODE	(114)
POLYGON	(100)	TEXTSIZE	(114)
PTINRECT	(101)	TEXTSTYLE	(114)
RDRAW	(103)	UNDERLINE	(116)
REAL.FONT?	(103)	UPPER.LEFT	(118)
RECT	(104)	VECTOR	(118)
RECTANGLE	(104)	WATCH	(120)
REGION	(104)	WHITE	(121)
RMOVE	(105)	XLATE	(122)
SCALE	(106)	XY><TLBR	(122)
SCALE>XY	(106)	XY>POINT	(122)
SCALE>Y	(106)	XYAXIS	(122)
SCREEN.BITS	(107)	XYOFFSET	(123)
SET.CURSOR	(108)	XYPIVOT	(123)
SET.ORIGIN	(109)	XYSCALE	(123)

16. String Manipulation:

Word	Page#	Word	Page#
"	(30)	CMOVE	(62)
$ADDR	(32)	CMOVE>	(62)
$LIT	(32)	COUNT	(64)
($LIT)	(33)	CRLF	(65)
(.")	(33)	ERASE	(71)
-TEXT	(44)	FILL	(73)
-TRAILING	(44)	MATCH	(89)
."	(44)	PAD	(97)
?WORD	(55)	UPPER	(117)
BLANKS	(60)		

17. User Interface:

Word	Page#	Word	Page#
(GET)	(35)	STATUS	(111)
>LIST<	(51)	STILL.DOWN	(111)
?ROOM	(54)	TRIAD	(116)
@INIT	(55)	VERSION	(118)
@MOUSE	(55)	VERSION#	(118)
@MOUSE.DN	(55)	WAIT	(120)
@MOUSEXY	(56)	WORDS	(122)
BYE	(60)		
DIR	(67)		
DIRECTORY	(67)		
FOLLOWER	(75)		
GET	(76)		
ID.	(81)		
MOUSE.BUTTON	(90)		
RELEASE	(104)		
SHOW	(109)		

18. Machine Interface:

Word	Page#
!SR	(30)
>JSR	(51)
@SR	(56)
DEVICE.CONTROL	(66)
DEVICE.STATUS	(66)
START.FLAG	(111)

19. Trace and Debug:

Word	Page#	Word	Page#
(.S)	(33)	ROOM	(105)
(TRACE)	(36)	SCR	(107)
?TRACE	(54)	SCRATCH	(107)
DEBUG	(65)	STACK.ERROR	(111)
DEBUG.ONLY	(66)	TRACE	(116)
DEPTH	(66)	TRACE.TOKEN	(116)
HANDLER	(79)	UNIQUE.MSG	(117)
INDEX	(83)		
INITIALS	(83)		
INPUT.NUMBER	(84)		
INPUT.STRING	(84)		
LIST	(87)		
LOWER.CASE	(88)		
NEEDED	(91)		
PAUSE	(98)		
QUIET	(101)		
R#	(102)		

20. Printer and Serial:

Word	Page#
+PRINTER	(39)
CONFIGURE.PRINTER	(63)
OPEN.DEVICE	(96)
OPEN.PRINTER	(96)
PRINT	(100)
PRINT.BITS	(100)
PRINT.FCB	(100)
PRINT.SCREEN	(100)
PRINT.WINDOW	(100)
PRINTER	(100)
PRINTER.ONLY	(101)
RST.PRINTER	(106)
SETUP.SERIAL	(109)

21. Event Related:

Word	Page*	Word	Page*
-KEYBOARD	(43)	KEY.DOWN	(85)
?DOUBLE.CLICK	(52)	KEY.STROKE	(85)
?EVENT	(53)	KEY.UP	(85)
@EVENT	(55)	MOUSE.DOWN	(91)
ABORT.EVENT	(56)	MOUSE.DOWN.RECORD	(91)
ACTIVATE.EVENT	(57)	MOUSE.UP	(91)
APPLE.MENU	(58)	MOUSE.UP.RECORD	(91)
AUTO.KEY	(58)	MOUSE.WAS..	(91)
COMMAND.KEY	(63)	NETWORK.EVENT	(92)
DISK.EVENT	(67)	NULL.EVENT	(94)
DO.EVENTS	(68)	POST.EVENT	(100)
DRVR.EVENT	(69)	UPDATE.EVENT	(117)
EVENT.LOOP	(71)	WAIT.MOUSE.UP	(120)
EVENT.RECORD	(72)		
EVENT.TABLE	(72)		
EVENTS	(72)		
FLUSH.EVENTS	(74)		

22. Misc. Constants:

Word	Page*	Word	Page*
"BLKS	(30)	1HOUR	(47)
"DATA	(31)	2	(47)
"M4TH	(31)	3	(48)
"PICT	(31)	4	(48)
"TEXT	(31)	B/BUF	(59)
*	(31)	BL	(59)
-1	(43)	BS	(60)
-2	(43)	C/L	(61)
-3	(43)		
-4	(43)		
0	(46)		
1	(46)		
12HOURS	(47)		
1DAY	(47)		

23. Sound Driver:

Word	Page*
?SOUND	(54)
APLAY	(58)
HUSH	(80)
OPEN.SOUND	(97)
PLAY	(99)
SOUND.FCB	(110)
SYSBEEP	(112)
TONE	(116)

24. Misc. Toolbox Words:

Word	Page*	Word	Page*
(TRACK.CONTROL)	(37)	PUSH.BUTTON	(101)
+TVISRECT	(40)	PUT.SCRAP	(101)
ADD.CONTROL	(57)	RADIO.BUTTON	(102)
ADD.RES.MENU	(57)	SCRAP.COUNTER	(107)
DISPOSE.CONTROL	(67)	SCRAP.HANDLE	(107)
DOWN.BUTTON	(68)	SCRAP.LEN	(107)
DRAW.CONTROLS	(69)	SET.CONTROL	(108)
GET.CONTROL	(76)	SET.CONTROL.MAX	(108)
GET.SCRAP	(77)	SET.CONTROL.MIN	(108)
HILITE.CONTROL	(79)	SET.CONTROL.RANGE	(108)
IN.BUTTON	(82)	SET.STRING	(109)
IN.CHECKBOX	(82)	SHOW.CONTROLS	(109)
IN.THUMB	(83)	SYSPARMS	(112)
KILL.CONTROLS	(85)	TEACTIVATE	(112)
LOAD.SCRAP	(87)	TECALTEXT	(112)
MASK.HANDLE	(89)	TECLICK	(112)
MUNGER	(91)	TECOPY	(112)
NEW.STRING	(92)	TECUT	(112)
OFF.CONTROL	(95)	TEDEACTIVATE	(112)
ON.CONTROL	(96)	TEDELETE	(112)
PAGE.DOWN	(97)	TEDISPOSE	(113)
PAGE.UP	(98)	TEIDLE	(113)

((24. Misc. Toolbox Words Continued))

TEINSERT	(113)
TEKEY	(113)
TENEW	(113)
TEPASTE	(113)
TERECORD	(113)
TESCROLL	(113)
TESET.JUST	(113)
TESET.SELECT	(113)
TESET.TEXT	(113)
TEST.CONTROL	(113)
TEUPDATE	(113)
TEXT.BOX	(113)
TEXT.CLICK	(114)
TEXT.FIELD	(114)
TEXT.RECORD	(114)
THIS.CONTROL	(115)
THIS.PART	(115)
TOGGLE.CONTROL	(115)
TRACK.CONTROL	(116)
UNLOAD.SCRAP	(117)
UP.BUTTON	(117)
ZERO.SCRAP	(123)

! n\addr --

Store n at addr. "store"
The error message "ADDRESS ERROR TRAP AT addr" indicates addr is odd (addr is displayed as a hexadecimal value) Refer to the Error Handling chapter for a further explanation. See also W! C!

!CSP ---

Save the current stack position in the user variable CSP . This is used as part of the compiler security to ensure the stack does not change during compilation of a word. "store-c-s-p"

!PENSTATE 20 bytes (5 stack items) --

Restores the prior penstate from the stack. See @PENSTATE .
"store pen state"

!POINT x\y\addr --

Packs the 16-bit values x and y into a 32-bit integer and stores the value at addr.

!RECT top\left\bottom\right\addr --

Packs the rectangle coordinates on the stack into 4 16-bit values and stores them at addr. Packed rectangle contains 4 16-bit elements in top-left-bottom-right sequence. "store rect"

!SR n --

Directly stores the least significant 16 bits of n into the 68000 hardware status register. The supervisor and trace modes, interrupt level, and condition codes are affected. "store-s-r"

" -- addr

Compiles a string delimited by " , leaving its address when the word is later executed. Used during compilation in the form:

" <string literal>"

to compile ($LIT) followed by <string literal> with its count in the first position. When later executed, ($LIT) places the address of <string literal> on the stack, advancing the instruction pointer to the word following the string literal. See $LIT , ($LIT) , ." , ,"
"quote"

"BLKS -- n

32-bit constant containing the 4 character ASCII string "BLKS" . Used to designate the blocks file type. "quote B-L-K-S "

"DATA -- n

32-bit constant containing the 4 character ACSII string "DATA" . Used as a file or resource type. "quote DATA "

"M4TH -- n

Constant MacFORTH File creator id code. Placed in the creator field of all files created by MacFORTH. "qoute M-4th"

"PICT -- n

32-bit constant containing the 4 character ASCII string "PICT". Used to designate a picture file or resource types. "quote P-I-C-T "

"TEXT -- n

32-bit constant containing the 4 character ASCII string "TEXT" . Used to designate text files or resource types. "quote TEXT "

n1 -- n2

Uses n1 to generate the next ASCII character for numeric output, leaving n2 as n1/BASE. The result n2 is maintained for further processing. Unchecked error if not used between <# and #> . See <# and #> . "sharp"

#> n -- addr\cnt

End pictured numeric output conversion. Drop n from the stack and leave the address and count of the text string created during numeric conversion. "sharp-greater"

#FILES -- n

Constant specifing the maximum number of files that can be opened at a time.

#FIND -1\voc addr 1\...\voc addr n -- [token\len\true] or [false]

Vocabulary search primitive. Searches the -1 terminated vocabulary list for the word in input stream. If the word is not found during the search, leaves a false flag. If the word is found, leaves its token, length byte and a true flag. Voc addr is the handle of the vocabulary token. "hash-find"

#S un -- 0

Converts all digits of unsigned un. Each is added to the pictured numeric output string until the remainder is zero. A single zero is added to the output string if un was initially zero. "sharp-s"

$ADDR -- addr

Skips over following in-line string literal, leaving address on stack. "string address"

$LIT -- addr\cnt

Executes ($LIT) . Necessary to match nesting level (return stack depth) for other inline string literal operators such as (ABORT") and (ERROR") which also use ($LIT) . See ($LIT) . "string-lit"

' -- pfa

Used in the form:

' <name>

to get the pfa of <name>. If executing, leave the pfa of the next word in the input stream. If compiling, compile this pfa as a relocated literal; later execution will place it on the stack. Issue an error message if the word is not found after a search of the CONTEXT and then the CURRENT vocabularies. Within a colon definition

```
 ' <name>
```

is identical to

```
 [ ' <name> ] LITERAL
```

Error if the following word is not found in the dictionary. The system will print the name followed by a question mark. "tick"

'INTERPRET ---

Begin interpretation of the input stream pointed to by >IN and BLK . If BLK is non-zero, >IN points to the character within the block pointed to by BLK . If BLK is zero, the input stream is taken from the Terminal Input Buffer. See >IN , BLK , TIB . "tick-interpret"

(---

Accepts and ignores comment characters from the input stream until the next right parenthesis. Used in the form:

(ccc) or (ccc)

The left parenthesis must be followed by at least one space (as with all FORTH words). It may be used freely while compiling or executing. The error message

MISSING (STRING DELIMITER !

indicates the input stream has been exhausted before the delimiting right parenthesis was encountered. "paren"

The delimiter (right parenthesis) is pronounced: "close-paren"

(!ON.ACTIVATE) --

Runtime word for !ON.ACTIVATE . Use !ON.ACTIVATE .

(!ON.UPDATE) --

Runtime word for !ON.UPDATE . Use !ON.UPDATE .

($LIT) -- addr

Fetches the inline string literal address from the return stack, leaving the string address on the stack. The value on the return stack (the instruction pointer) is incremented to point just past the string, so when ($LIT) executes EXIT , execution will continue beyond the string literal. "paren-string-lit"

((ABORT)) ---

Default version of ABORT (initially placed in (ABORT)). Empties the data stack, sets BASE to DECIMAL, copies TRUNK to CONTEXT and CURRENT, and finally QUITs, which aborts execution and returns control to the console. "paren-paren-abort"

((ERROR)) addr\cnt --

Default error handler (initially placed in (ERROR)). If QUIET is off, sounds the console's buzzer, outputs a CR LF and the most recently interpreted word (from POCKET) followed by the string at the addr and cnt given. The data stack is cleared. If BLK is non-zero (compiling from disc), SCR is set to BLK , and R* is set to >IN , so that entry into the editor will point to the location of the error. Finally, QUIT is executed, aborting the current task and returning control to the console. See (ERROR) , POCKET , BLK , >IN , WHERE . "paren-paren-error"

(+LOOP) n --

The run-time procedure compiled by +LOOP. It increments the loop index by n and tests for loop completion. See +LOOP . "paren-plus-loop"

(.") ---

The run-time procedure compiled by " Outputs the string immediately following it in the dictionary. See ." "paren-dot-quote"

(.S) ---

Non-destructive stack display primitive. No CR before execution. Displays the contents of the stack using the following format:

```
[d] c\b\a
```

where d is the stack depth, and a b and c are the top three stack items. If d is less than 3, only the stack items present are displayed.

(;CODE@) ---

Stores the supplied cfa into the cfa of the latest word. The supplied cfa is pointed to by the value on the return stack.

(>CODE) ---

Jumps to the address contained in the IP. Compiled by >CODE .

(ABORT") flag --

Primitive routine compiled by ABORT" which precedes the inline string literal. When executed, if flag is true, the string is output and ABORT is executed. If flag is false, flag is dropped from the stack and execution resumes at the word following the string literal. "paren-abort-quote"

(ABORT) -- addr

User variable containing the cfa to be executed by ABORT . "paren-abort"

(DO) n1\n2 --

The run-time procedure compiled by DO , which moves the loop control parameters to the return stack. See DO . "paren-do"

(ERROR") flag --

Compiled by ERROR" prior to an inline error message string. When executed, if flag is true, the most recently executed word (in POCKET) is displayed, followed by the inline error message string. If flag is false, flag is dropped from the data stack and execution continues beyond the string. See $LIT , ($LIT) , ERROR" , ABORT" . "paren-error-quote"

(ERROR) -- addr

User variable containing the address of the word to be executed when an error is detected by the text interpreter. "paren-error"

(EXCPT) ---

Code definition which copies the contents of the 68000 registers to the array REG.SET . The first 16 bytes on the return stack (hardware stack pointer) are also moved. This routine is called by all of the processor and unimplemented instruction handlers during exception processing before they execute ABORT , providing a snapshot of the registers and the supervisor stack when the exception occured. The loadable utility .REGS (MacFORTH Level 2) will give you a formatted dump of this information. Use the Motorola Processor Exeception Documentation to interpret the supervisor stack contents. "paren-except"

(FIND) addr\voc handle -- [token\prec flag\true] or [false]

Vocabulary search primitive. Searches the vocabulary for a match with the name found at addr. If a match is found, the token and precedence flag for the word are returned under a true flag, otherwise only a false flag is returned. "paren-find"

(GET) addr --

Multitasking stub for source compatibility with future CSI MacFORTH products.

(GET.FILE) n1\n2\n3\n4\n5\ --

Standard file hook for uniform access to the Macintosh standard file package. Unsupported in Level 1. "paren GET.FILE "

(LINE) x\y --

QuickDraw line primitive. X and Y are expressed in local window QuickDraw coordinates and are unaffected by XYSCALE, XYPIVOT, or XYORIGIN. "paren line"

(LINE.TO) x\y --

QuickDraw relative line drawing primitive. X and Y are in local window QuickDraw coordinates and are unaffected by XYSCALE, XYPIVOT, or XYORIGIN. "paren line-to"

(LOOP) ---

The run-time procedure compiled by LOOP which increments the loop index and tests for loop completion. See LOOP . "paren-loop"

(MENU.SELECTION:) --

Run time code for MENU.SELECTION: retained for clarity during tracing. "paren menu selection"

(MOVE) X\Y --

QuickDraw line drawing primitive. X and Y are in local window QuickDraw coordinates and are unaffected by XYSCALE, XYPIVOT, or XYORIGIN. "paren move"

(MOVE.TO) X\Y --

QuickDraw line drawing primitive. X and Y are in local window QuickDraw coordinates and are unaffected by XYSCALE, XYPIVOT, or XYORIGIN. "paren move-to"

(OF) n1\n2 -- [n1] or []

Run-time code compiled by OF . See OF .

(ON.ERROR) ---

Pushes the recovery stack frame into the return stack. It then branches over the error recovery code.

(PENSIZE) w/h --

Sets PENSIZE regardless of XY scale. "paren pen size"

(PUT.FILE) n1\n2\n3\n4 --

Standard file hook for uniform access to the Macintosh standard file package. Unsupported in Level 1. "paren PUT.FILE"

(R/W) -- addr

User Variable containing the address of the word which obtains a requested block from the disc. "paren-r-slash-w"

(TEXTSIZE) size --

Sets physical text size regardless of Y scaling. "paren textsize"

(TRACE) ---

Routine which executes the trace function of the compiler. Compiled by the interpreter before every token if the TRACE option switch is on. When the later executed, if the DEBUG option switch is on, output is tabbed to column 16, the stack is displayed (using (.S)). A CRLF is output, and the name field of the following inline token is displayed. If the DEBUG option switch is off, no output is generated. See TRACE , DEBUG . "paren trace"

(TRACK.CONTROL) n1\n2\n3 -- flag

MacFORTH Level 2 controls primitive. Refer to MacFORTH Level 2 documentation.

(WORD) char\addr -- addr

Moves the string delimited by char from the input stream to addr. "paren-word"

)CONSTANT n --

Creates a relocatable constant. Similar to CONSTANT, used in the form:

```
   n )CONSTANT <name>
```

to create a relocatable constant with name <name> and value n. When created, NEXT.PTR is subtracted from the stored 32 bit value. When the constant is later used, the saved value is summed with NEXT.PTR to produce the actual physical address.

)U addr -- n

Converts the user area address given to the offset from the base of the user area. It is simply defined as:

```
  : )U  STATUS - ;
```

It is used to access the bootup literal area. "close-paren-u"

***** n1\n2 -- n3

Leaves the product of (n1*n2). Error if the product is greater than 31-bits plus sign. System response is to truncate the product to 32-bits with no error message. "times"

***/** n1\n2\n3 -- n4

Leaves the result of the product n1 times n2 divided by n3. The result n4 is rounded toward zero. The intermediate product (n1*n2), is maintained as a 64-bit value for greater precision than the otherwise equivalent sequence: n1 n2 * n3 /

Error if division by zero, or quotient overflows, with NO system check. "times-divide"

***/MOD** n1\n2\n3 -- n4\n5

Multiply n1 by n2, divide the result by n3, leaving the remainder n4 and quotient n5. A 64-bit intermediate product is used (as for */). The remainder has the same sign as n1. Error if division by zero, or quotient overflows with NO system check. "times-divide-mod"

+ n1\n2 -- n3

Add n1 to n2 and leave the result n3. Error if the sum overflows resulting in a 32-bit truncated unnormalized sum with no system check. "plus"

+! n\addr --

Add n to the 32-bit value at addr according to the convention for +. Error if the sum overflows with no system check (see +). The error message "ADDRESS ERROR TRAP at addr" indicates addr is odd (see !). "plus-store"

+CARTESIAN wptr -- addr

Returns the address of a variable in the window record (for the window specified by wptr) whose contents determine whether coordinate points for the window are to be interpreted in QuickDraw or Cartesian coordinates (see the Graphics Results chapter). When the variable is TRUE, all coordinates are expressed in Cartesian coordinates. "plus Cartesian"

+FIND -- [token\flag\true] or [false]

Dictionary search primitive. Searches the dictionary for a match on the next word in the input stream. The next word in the input stream is extracted using WORD and placed in POCKET . If the word is found in the CONTEXT , CURRENT , or TRUNK vocabularies, the token for the word, its precedence flag and true flag are returned. The precedence flag is true if the word is an immediate word and should be executed when compiling (ie. DO , IF , ."). If the word is not found, only a false flag is returned. See IMMEDIATE , CREATE , WORD , POCKET . "plus-find"

+FOLLOWER n1 -- n1+FOLLOWER

Returns the sum of n1 plus the offset to the user variable FOLLOWER from the base of the user area.

+HBAR wptr -- wptr+offset

Returns the address of a variable within a window record which contains the handle for a horizontal scroll bar control which is attached to the window specified by wptr. Refer to MacFORTH Level 2 Controls documentation for further information.

+LOAD relative scr# --

Loads the screen number given relative to the current screen being loaded. For example, the sequence

```
10 +LOAD
```

encountered while loading screen 100 would cause screen 110 to be loaded. "plus-load"

+LOOP n --

Add the signed increment n to the loop index using the convention for + and compare the total to the limit. Return execution to the corresponding DO until the new index is equal to or greater then the limit (for n>0), or until the new index is less than the limit (for n<0). Upon exit from the loop, discard the loop control parameters from the return stack and pass control to the word following +LOOP . The error message "CONDITIONALS NOT PAIRED" indicates the +LOOP was not matched with a DO . See DO . "plus-loop"

+MAX.BLK# fcb -- addr

Returns the address of trhe maximum block number field (32-bits) in the file control block. For example,

```
0 >FCB  +MAX.BLK#  @
```

returns the maximum number of blocks in the blocks file with file number 0.

+ON.ACTIVATE wptr -- addr

Returns the address of the field within the window record (specified by wptr) which contains the token to be executed when the window is activated.

+ON.UPDATE wptr -- addr

Returns the address of the field within the window record (specified by wptr) which contains the token to be executed when the window is updated.

+POINT X1\Y1\X2\Y2 -- X1+X2\Y1+Y2

Returns the sum of two points.

+PRINTER addr\cnt --

If the value of the variable PRINTER is true, the string at addr for cnt bytes is output to the printer, then to the display. If the value of PRINTER is false, the string is only displayed. "plus-printer"

+REC.SIZE fcb -- addr

Returns the address of the record size element (16-bits) in the specified file control block. For example:

```
   0 >FCB  +REC.SIZE W@
```

returns the record size of the file with file number zero.

+SCR# fcb -- addr

Returns the address of the block (or "screen") number field (32-bits) in the specified file control block.

+THRU relative start\relative end --

Load screens start through end relative to the current screen. For example, the sequence

```
   5 15 +THRU
```

encountered while loading screen 10 would cause screens 15 through 25 to be loaded. "plus-thru"

+TVISRECT text record addr -- addr

Returns the address of the visible rectangle field within the text edit record. Refer to MacFORTH Level 2 Text Edit interface documentation for further details.

+VBAR wptr -- addr

Returns the address of a variable within the window record which contains the handle for a vertical scroll bar control which is attached to the window. Refer to MacFORTH Level 2 Controls documentation for further information.

+W.ATTRIBUTES wptr -- addr

Returns the address of the 16-bit field within the window record (specified by wptr) which contains the window attributes to be assigned when the window is created:

```
    bit0  CLOSE.BOX              bit1  NOT.VISIBLE
    bit2  SIZE.BOX               bit3  SCROLL.UP/DOWN
    bit4  SCROLL.LEFT/RIGHT      bit5  TEXT.RECORD
    bits 6-15 Reserved
```

+W.BEHIND wptr -- addr

Returns the address of the field within the window record (specified by wptr) which contains the wptr to place the new window behind when it is created. 0 places it up front, -1 places it at back.

+W.LINK wptr -- addr

Returns the address of the field within the window record (specified by wptr) which contains the address of the prior chronologically defined window. This linked list is traversed, during FORGET, to close any windows which are about to be forgotten.

+W.TYPE wptr -- addr

Returns the address of a 16-bit field within the window record which contains the window type. Type 0 is a document window, type 1 is a dialog box window, type 2 is a rectangle, and type 3 is a shadowed rectangle.

+WBOUNDS wptr --addr

Returns the address within the window record (specified by wptr) of a rectangle to be used as the window bounds when the window is created.

+WCBOUNDS wptr -- addr

Returns the address within the window record of the current content area rectangle for the window. This rectangle is kept current when the window is resized, and reflects the presence or absence of scroll bars.

+WFILE.PTR wptr -- addr

Returns the address within the window record of a field which contains the file number of file which is associated with the specified window.

+WLINE.HEIGHT wptr -- addr

Returns the address within the window record of a field which contains the current line height. Windows are scrolled by the value contained in this field bits up at the end of the screen.

+WREFCON wptr -- addr

Returns the address within the window record of a field which contains the window reference constant. This field normally contains the address of the handle for the current Text Edit record. Refer to MacFORTH Level 2 Text Edit documentation for further information.

+WTITLE wptr -- addr

Returns the address within the window record of a variable which contains the address of a string to be used as the window title. Executed when the window is created with ADD.WINDOW .

+XYBIAS wptr -- addr

Returns the address within the window record of a 32-bit field which contains the integer 16-bit sine and cosine of the current XYPIVOT angle.

+XYOFFSET wptr -- addr

Returns the address within the window record of a 32-bit field which contains the 16-bit Y and X offsets which are applied to all coordinates relating to the window.

+XYPIVOT wptr -- addr

Returns the address within the window record of a 16-bit field which contains the angle of rotation to be applied to all coordinates relating to the window.

+XYPOS wptr -- addr

Returns the address within the window record of a 32-bit field containing the current XY position. This is used for all relative coordinates.

+XYSCALE wptr -- addr

Returns the address within the window record of a field which contains the current XYSCALE to be applied to all window coordinates.

, n --

Allot 4 bytes in the dictionary, storing n there. An error is reported if insufficient object space is available. "comma"

," ---

Compiles a string literal into the dictionary. Extracts the following string, terminated by " (double quote), from the input stream and emplaces it into the dictionary preceded by its count byte. For example:

```
  CREATE TEST.STRING ," THIS IS A TEST" TEST.STRING COUNT TYPE
```

will output

```
  THIS IS A TEST
```

This operator is generally used to emplace string literals into the dictionary for words like ." , ABORT" , ERROR" , etc. "comma-quote"

- n1\n2 -- n3

Subtract n2 from n1 and leave the difference n3. Error if the difference overflows. Returns a 32-bit value similar to that of the case of overflow from addition with no system check. See + . "minus"

--> ---

Continue interpretation on the next sequential block. May be used in a colon or code definition that crosses a block boundary. "next-block"

-1 -- -1

Constant containing the value -1.

-2 -- -2

Constant containing the value -2.

-3 -- -3

Constant containing the value -3.

-4 -- -4

Constant containing the value -4.

-FIND -- [token\flag\true] or [false]

Dictionary search primitive. Searches the dictionary for a match on the next word in the input stream. Extracts the next word in the input stream (via WORD), placing it in POCKET . If the word is found in the CONTEXT or TRUNK vocabularies, the token for the word, its precedence flag, and a true flag are returned. The precedence flag is true if the word is immediate and should be executed when compiling (ie. DO , IF , ."). If the word is not found, a false flag is returned. See IMMEDIATE , INTERPRET .
"dash-find"

-FOUND token --

Reports an error " ?" if token is zero.

-KEYBOARD -- n

Constant mask which allows all but keyboard events to be received. This value is ended with the contents of EVENTS if a keystroke already exists prior to execution of DO.EVENTS allowing type-ahead.
"minus-keyboard"

-LATEST --

Removes the latest token, name, and object space from current dictionary. It ignores the smudge bit.
"minus-latest"

-NULL ---

Aborts if the first byte at **POCKET** equals zero with the message "ATTEMPTED TO REDEFINE NULL!"

-POINT x1\y1\x2\y2 -- x1-x2\y1-y2

Returns the difference of two points. See +POINT .

-STRING addr1\addr2 -- flag

Returns a non-zero flag if the string at addr1 is not equal to the string at addr2. The first byte of each string contains its length. Case and diacritical marks are ignored (eg. "Tåsk" and "TASK" are considered equal).

-TEXT addr1\cnt\addr2 -- flag

Compares the two strings at addr1 and addr2 for cnt bytes. The flag returned is zero if the strings are equivalent, otherwise the flag equals the difference between the last two characters compared, as follows: addr1(i) - addr2(i)
"dash-text"

-TRAILING addr\cnt1 -- addr\cnt2

Strips trailing blanks from the string at addr. Adjusts the character count cnt1 of a text string beginning at addr to omit trailing blanks (ie. the characters from addr+cnt1 to addr+cnt2 are blanks). Error if cnt1 is negative with no system check.
"minus-trailing"

. n --

Displays n. n is converted according to BASE in a free format field with one trailing blank. Displays a negative sign if n is negative.
"dot"

." ---

Outputs a string of text delimited by " . Executed or compiled in the form

." aaaaaaaa"

Accept the following text from the input stream, terminated by " (double-quote). If executing, transmit this text to the selected output device. If compiling, compile so that later execution will transmit the text to the output device. Up to 255 characters are allowed in the text. The error message "MISSING STRING DELIMITER" indicates the input stream was exhausted before the delimiting double quote was encountered. "dot-quote"
The double quote delimiter is pronounced "quote"

.ABORT n --

Prints the number n in hexadecimal, and aborts.

.DATE$ ---

Displays the current date from the internal clock in the following format: MM/DD/YY

.FILE.ERROR error number --

Displays the appropriate file error message for the given file error number. Unknown error numbers are printed with the message "File Error #".

.R n\width --

Displays n right-justified, blank-filled. The field is width characters wide, and n is displayed according to BASE. If width is less than 1, no leading blanks are supplied. "dot-r"

.S ---

Non-destructively displays the current contents of the stack. The number of items on the stack is first displayed, enclosed in brackets, followed by the top three stack items (the top stack item is furthest to the right) after a carriage return. For example, if you enter

```
   1 2 3  .S
```

you will see

```
   [ 3 ] \ 1 \ 2 \ 3
```

If you then add another stack item (say 4 for example), you will see

```
   [ 4 ] \ 2 \ 3 \ 4
```

"dot-s"

.TIME$ ---

Displays the current time as read from the internal clock in the following format: HH:MM:SS XM

.TYPE addr\cnt --

Default Macintosh console output operator. Scrolls up at the bottom of the screen.

/ n1\n2 -- n3

Divide n1 by n2, leaving the quotient n3. n3 is rounded toward zero (truncated). Error on division by zero with no system check. "divide"

/MOD n1\n2 -- remainder\quotient

Divide n1 by n2 and leave the remainder under the quotient. The remainder has the same sign as n1. Error on division by zero with no system check. "divide-mod"

0 -- 0

Constant containing the value 0.

0< n -- flag

Returns a true flag if n is less than zero (negative). "zero-less"

0= n -- flag

Returns a true flag if n is equal to zero. "zero-equals"

0> n -- flag

Returns a true flag if n is greater than zero. "zero-greater"

0BRANCH flag --

The run-time procedure used for conditional branching. If flag is false (zero), the following in-line parameter is added to the interpreter pointer to branch ahead or back. Compiled by IF , UNTIL , and WHILE . "zero-branch"

0MAX n -- [n] or [0]

Code routine which returns the maximum of n or 0. "zero-max"

1 -- 1

Constant containing the value 1.

1+ n -- n+1

Increments the top stack item by one.

1- n -- n-1

Decrements the top stack item by one.

10+ n -- n+10

Increments the top stack item by ten.

10- n -- n-10

Decrements the top stack item by ten.

12HOURS -- n

Constant returning the number of seconds in 12 hours.

16* n -- n*16

Multiplies the top stack item by sixteen.

16+ n -- n+16

Increments the top stack item by sixteen.

16- n -- n-16

Decrements the top stack item by sixteen.

16/ n -- n/16

Divides the top stack item by sixteen.

1DAY -- n

Constant returning the number of seconds in one day.

1HOUR -- n

Constant returning the number of seconds in one hour.

2 -- 2

Constant containing the value 2.

2! n1\n2\addr --

Stores n2 at addr, n1 at addr+4.

2* n -- n*2

Multiplies the top stack item by 2.

2+ n -- n+2

Increments the top stack item by 2.

2- n -- n-2

Decrements the top stack item by 2.

2/ n -- n/2

Divides the top stack item by 2.

2@ addr -- n1\n2

Fetches n2 from addr, n1 from addr+4.

2DROP n1\n2 --
Drops n1 and n2 from the stack.

2DUP n1\n2 -- n1\n2\n1\n2
Duplicates n1 and n2.

2OVER n1\n2\n3\n4 -- n1\n2\n3\n4\n1\n2
Copies n1 and n2 to the top of the stack.

2SWAP n1\n2\n3\n4 -- n3\n4\n1\n2
Swaps n1,n2 with n3,n4.

2W>MT n1 --
Macintosh Tooltrap interface word. See the Advanced Topics toolbox interface section for more information.

3 -- 3
Constant containing the value 3.

3+ n -- n+3
Increments the top of the stack by three.

3- n -- n-3
Decrements the top of the stack by three.

4 -- 4
Constant containing the value 4.

4* n -- n*4
Multiplies the top of the stack by four.

4+ n -- n+4
Increments the top stack item by 4.

4- n -- n-4
Decrements the top stack item by 4.

4/ n -- n/4
Divides the top stack item by 4.

5+ n -- n+5
Increments the top stack item by 5.

5- n -- n-5
Decrements the top stack item by 5.

6+ n -- n+6
Increments the top stack item by 6.

6- n -- n-6
Decrements the top stack item by 6.

7+ n -- n+7
Increments the top stack item by 7.

7- n -- n-7
Decrements the top stack item by 7.

8* n -- n*8
Multiplies the top stack item by 8.

8+ n -- n+8
Increments the top stack item by 8.

8- n -- n-8
Decrements the top stack item by 8.

8/ n -- n/8
Divides the top stack item by 8.

: ---

Begins compilation of a new definition. A defining word used in the form:

```
: <name>  . . . ;
```

Set CONTEXT to CURRENT and create a dictionary entry for <name> in the CURRENT vocabulary. Words thus defined are "colon definitions" and the compilation address of subsequent words from the input stream which are not immediate are compiled into the dictionary to be later executed when <name> is executed. IMMEDIATE words are executed as encountered. Words encountered that are not found in the dictionary (CONTEXT and TRUNK vocabularies) cause compilation to stop with a question mark printed after the offending word. The warning message "ISN'T UNIQUE" indicates that a previous definition for <name> exists. "colon"

; ---

Terminate a colon definition and stop compilation. The error message "DEFINITION INCOMPLETE" indicates the stack depth changed within the current colon definition. "semicolon"

< n1\n2 -- flag

Returns a true flag if n1 is less than n2. "less-than"

<# ---

Initialize pictured numeric output. The following group of words are used to convert a number to its ASCII string equivalent:
<# #> # #S HOLD SIGN
"less-sharp"

<W@ addr -- n

Fetches the 16-bit contents at addr and sign extends it to 32-bits. An address error trap will result if add is odd. Use >W@< for odd or even addresses.
"extended-word-fetch"

= n1\n2 -- flag

Returns a true flag if n1 is equal to n2. "equals"

=CELLS n1 -- n2

Ensures n1 is even by adding one to it if it is odd. "equals-cells"

=DROP n1\n2 -- [n1\n2] or [n1]

Drops n2 if n1=n2. "equals-drop"

> n1\n2 -- flag

Returns a true flag if n1 is greater than n2. "greater-than"

>.FILE.ERROR< error code --

Default file error handler. Displays the appropriate error message for the error code given.

>FCB file# -- fcb

Returns the file control block address for the file number specified.

>IN -- addr

User variable pointing to the current character in the input stream. Error if the value stored is outside the range 0 to 1023 with no system response. See : WORD ' (." and FIND . "to-in"

>JSR addr --

Jumps to the assembly code subroutine at addr. Registers A0-A2, D0-D3 are available; A3-A7, and D4-D7 should be saved and restored by the assembly routine if they would be modified. The JSR instruction places the address (containing NEXT) on the return stack (A7). Return to FORTH via an RTS instruction. NOTE: MacFORTH expects to run in supervisor state, NOT user state. "to-j-s-r"

>LIST< ---

Indirectly references the word to execute at the top of every listed screen. Used to time and date stamp listings.

>R n --

Pushes the top stack item onto the return stack. Remember, DO . . . LOOP's affects the return stack. (DO pushes 2 items, LOOP pops them). Error if not balanced inside of a colon definition or inside a DO . . . LOOP structure with a matching R> with an unpredictable system response. "to-r"

>RECT x1\y1\x2\y2 -- RB\LT\SP@

Returns the address within the stack of the reformatted rectangle x1\y1\x2\y2. Rectangle coordinates are translated and offset according to XYSCALE, XYPIVOT, and XYOFFSET before reformatting occurs. The rectangle is in QuickDraw top,left, bottom, right format.

>SYS.WINDOW ---

Directs output to system window.

>W!< n\addr --

Stores the 16-bit value n at addr. Addr may be an odd address.

>W@< addr -- n

Fetches the 16-bit value at addr. Addr may be an odd address.

? addr --

Displays the 32-bit value at addr. "question mark"

?ALIGN ---

Forces the dictionary pointer to an even address. The user variable DP is incremented by one if it is odd. "query-align"

?BLOCKS.FILE file# -- flag

Returns a true flag if the specified file is a BLKS type file. "query blocks file"

?COMP ---

Verifies compilation state. Issues the error message "COMPILATION ONLY! USE ONLY IN A DEFINITION" if STATE does not indicate compilation mode. "query-comp"

?CSP ---

Verifies the stack did not change during compilation. The error message "DEFINITION INCOMPLETE !" indicates the value in the user variable CSP is different from the current stack position. See CSP . "query-c-s-p"

?DAYS n1 -- n2

Converts n1 seconds into n2 days. n1 is divided by the number of seconds in one day, leaving the result n2.

?DOUBLE.CLICK -- flag

Following a mouse down event, detects if a double click occurs within the time period set on the control panel. If a double click occurs, flag is true, otherwise false.

?DUP n -- [n\n] or [n]

Duplicate n if it is non-zero. "query-dup"

?EOF -- flag

Returns a true flag if the end-of-file marker of the current file has been reached for the file that was most recenty accessed.

?EVENT record\mask -- event code

Copies the next event that passes the mask to record, returning the event code of the event. The event is not removed from the event queue. "query-event"

?EXEC ---

Verifies execution state. Issue the error message EXECUTION ONLY if STATE does not indicate execution mode. "query-exec"

?FILE.ERROR ---

Checks the value of IO-RESULT and aborts the current task, displaying an error message if IO-RESULT is non-zero.

?FILES ---

Displays the current file control block assignments.

?HEAP.SIZE -- size

Returns total amount of space available in heap, including any grow region. Refer to Apple Developer's documentation for further detail Reference: FreeMem

?IN.CONTROL --flag

Returns a true flag if most recent MOUSE.DOWN even occurred in a control attached to the currently active window. The variable THIS.CONTROL contains the handle to the affected control. The variable THIS.PART contains the relevant control part code. Refer to MacFORTH Level 2 Controls documentation for further details.

?KEYSTROKE -- [key\true] or [false]

Checks for a keystroke from the Mac keyboard. Returns a key value under a true flag if a key was pressed, otherwise just returns a false flag.

?LOADING ---

Verifies loading from disc. Issue the error message "CAN'T USE FROM TERMINAL !" if a word is executed from the terminal which should only be executed from disc. "query-loading"

?OPEN file# -- flag

Returns a true flag if the specified file is open.

?PAIRS n1\n2 --

Verifies conditionals were paired in the latest definition. The error message "CONDITIONALS NOT PAIRED" indicates n1 is not equal to n2, meaning compiled conditionals do not match. "query-pairs"

?PUNCT addr -- flag

Checks for valid punctuation. Returns a true flag if the ASCII character at addr is one of the following:

, . / :

"query-punct"

?ROOM ---

Reports the amount of space available in the heap, object and vocabulary memory areas.

?SECONDS n1 -- n2

Converts n1 seconds into n2 seconds since midnight of the current day. n1 is divided by the number of seconds in one day, leaving the remainder n2.

?SOUND -- flag

Returns a true flag if sound driver is active asynchronously.

?STACK ---

Checks for underflow of the parameter stack. The message "STACK EMPTY!" indicates the parameter stack underflowed.
"query-stack"

?TERMINAL -- flag

Returns a non-zero flag if a key has been pressed, otherwise false.
"query-terminal"

?TRACE ---

Compile (TRACE) into the dictionary if the TRACE option switch is on.
"query-trace"

?WORD char -- addr

Parses a string from the input stream. Performs the same function as WORD (see WORD), except it aborts with the error message "MISSING STRING DELIMITER!" if the input stream is exhausted before the delimiter was encountered. "query-word"

@ addr -- n

Returns the 32-bit contents of addr. The error message "ADDRESS ERROR TRAP AT addr" indicates addr was odd. If you need to fetch data from odd addresses, use CMOVE or >W@< .
"fetch"

@@ addr -- n

Returns the 32-bit contents of the contents pointed to by addr. The error message "ADDRESS ERROR TRAP AT addr" indicates addr or its contents were odd.
"fetch-fetch"

@CLOCK -- n

Returns the number of seconds since 12:00 am 01/01/04 as read from the internal clock.

@EVENT record\mask -- event code

Copies next event from event queue to record. Returns event code if it applies to current window, otherwise 0.

@FILE.NAME file# -- file$

Returns the address of the name string for the specified file.

@INIT ---

Asks for input of the user's initials. The message:
ENTER YOUR INITIALS [XXX] -->
The initials input are stored in the user variable INITIALS.

@MOUSE -- point

Returns the current location of mouse in local coordinates.
See POINT>XY LOCAL>GLOBAL

@MOUSE.DN --point

Returns the location of where the mouse last went down (button pressed) in local coordinates. See POINT>XY LOCAL>GLOBAL

@MOUSEXY --x\y

Returns mouse position in user window coordinates. Sensitive to CARTESIAN flag and XYOFFSET.

@PEN -- x\y

Returns the current pen position in local coordinates to the currently active window.

@PENSTATE -- 20 bytes (5 stack items)

Fetches the current pen size, pen pattern, pen location, and pen mode to the stack. (see !PENSTATE)

@POINT addr -- x\y

Fetches 32-bit value from addr and unpacks to x and y coordinates.

@RECT addr -- t\l\b\r

Unpacks rectangle at address. Top Left Bottom Right are pushed into stack.

@SR -- n

Returns the contents of the 68000 hardware status register. This 16-bit value is contained in the least significant bits of n. "fetch-s-r"

ABORT ---

Aborts the current task. Clears the data and return stacks and returns control to the console in execution mode.

ABORT" flag --

Aborts the current task with the supplied message if flag is true and RETRY is zero. Used in the form:

ABORT" <user message>"

Compiles (ABORT") followed by <user message> preceded by its count byte. At execution time, if flag is true, <user message> is displayed in the MacFORTH window, and ABORT is executed. If flag is false, no action is taken. If RETRY is non-zero, error recovery occurs at the stack frame in the return stack pointed at by RETRY .
See the Advanced Topics chapter and ABORT , (ABORT") , RETRY .
"abort-quote"

ABORT.EVENT -- n

Constant event code returned by DO.EVENTS on an abort event.

ABS n1 -- n2

Returns n2 as the absolute value of n1. Error occurs when the argument is the most negative 32-bit number. That argument is returned unchanged with no error message. "absolute"

ACTIVATE.EVENT -- n

Constant event code returned by DO.EVENTS on an activate event.

ADD.BLOCKS #blocks\file# --

Primitive used by APPEND.BLOCKS to add #blocks to the specified blocks file.

ADD.CONTROL xxx -- xxx

Refer to MacFORTH Level 2 Controls Documentation.

ADD.RES.MENU type\menu id --

Appends as items the name of all resources in the current resource file of the specfied type to the specfied menu.

ADD.WINDOW wptr --

Builds a window from w.title, w.bounds, w.type, and w.attributes, and links it into window list and displays it if visible. W.BEHIND determines where window will appear in the window list.
See NEW.WINDOW

AGAIN ---

Marks the end of an infinite loop structure. Causes an unconditional branch back to the start of a

```
   BEGIN . . . AGAIN
```

loop construct. It is equivalent to

```
   BEGIN . . . 0 UNTIL
```

See BEGIN , UNTIL .

ALIT -- address

Pushes the sum of the next 32-bit value in the interpretation stream and NEXT.PTR into the stack. Advances over the value. Compiled by ' to relocate a literal address.

ALLOCATE file size\file# --

Allocates the specified number of bytes to the specified file.

ALLOT n --

Increments the dictionary pointer by n. Aborts if object area is too small to contain n additional bytes.

AND n1\n2 -- n3

Returns n3 as the bitwise logical AND of n1 and n2.

APLAY addr --

Passes addr+2 to the Macintosh sound driver. Addr contains the 16-bit size of the waveform record at addr+2. The sound is generated asynchronoously.

APPEND token\$addr --

Appends the string with token to the current vocabulary. An error message is generated if insufficient space is available in the vocabulary. Resize the vocabulary with RESIZE.VOCAB .

APPEND.BLOCKS n\file # --

Appends n blocks to the blocks file specified by file#.

APPEND.ITEMS item$\menu id --

Appends elements in the item$ (separated by ';') to the specified menu.

APPLE.MENU ---

Installs the Apple desk accessory menu on the menu bar.

ARC x1\y1\x2\y2\sa\ca\[pattern addr]\mode --

Draws an arc within the rectangle (x1,y1,x2,y2) starting at angle sa (start angle) and ending at angle ca (completion angle). The pattern addr is required for the PATTERN mode.

ASSIGN file$\file# --

Assigns the file name specified to the file number specified. Any file previously assigned to file# is closed before the new file is assigned. See OPEN"

AUTO.KEY -- n

Constant event code returned by DO.EVENTS on an auto key (repeat) event.

AXE ---

Looks up and removes the next word in the input stream from the current vocabulary. The vocabulary is closed up to recover space. Object space for the word is not affected.

B/BUF -- n

Returns the number of bytes per block buffer (1024).
"b-slash-buf"

BACK addr --

Calculates the backward branch offset from HERE to addr. It is then compiled into the next available 16-bit memory cell in the dictionary.

BACKPAT pattern addr --

Sets the QuickDraw background pattern to the supplied pattern address.

BASE -- addr

User variable containing the current I/O numeric conversion base. Error if the value in BASE is outside the range 2 through 70 with no system check.

BEGIN ---

Marks the start of a loop structure for repetitive execution. Used in a colon definition in one of the following forms:

```
BEGIN . . . UNTIL
BEGIN . . . AGAIN
BEGIN . . . WHILE . . . REPEAT
```

The words after UNTIL and REPEAT (remember, BEGIN ... AGAIN is an endless loop -- see AGAIN) will be executed after the loop terminates. The error message "DEFINITION INCOMPLETE !" indicates the BEGIN was not matched with an UNTIL , AGAIN , or WHILE ... REPEAT sequence.

BEHEAD token --

Removes the name and token fields for the supplied token from the current vocabulary.

BL -- 32 (decimal)

Returns the value for the ASCII blank character. "b-l"

BLACK -- addr

Returns the address of the black pattern.

BLANKS addr\cnt --

Fills memory at addr for cnt bytes with ASCII blanks. See FILL

BLK -- addr

User variable containing the block currently being interpreted as the input stream. If BLK is zero, the input stream is coming directly from the terminal. "b-l-k"

BLOCK block# -- addr

Returns the buffer address of the requested block number. If the requested block is not already in a block buffer, it is transferred from mass storage into the least recently accessed buffer. If the previous data in that buffer has been UPDATEd, it is written out to mass storage before the new block is read in. Only data within the latest block referenced by BLOCK is valid due to sharing of the block buffers.

BLOCK-FILE -- addr

Variable containing the file number of the current blocks file.

BOLD -- 1

Constant bit mask for bold text attribute.

BOOLEAN n -- true or false

Converts n to a true flag (-1) if n is non-zero.

BRANCH ---

The run-time procedure to unconditionally branch. An inline offset is added to the interpreter pointer, IP , to branch ahead or back. BRANCH is compiled by ELSE , AGAIN , and REPEAT .

BRING.TO.FRONT wptr --

Brings the window specified by wptr to the front.

BS -- 08 (decimal)

Returns the value for the ASCII backspace character.

BUFFER block# -- buffer addr

Returns the addr of an available block buffer for the block number given.

BYE --

Exits MacFORTH, passing control to Finder.

C! char\addr --

Stores the 8-bit value char at addr. "c-store"

C, char --

Emplaces char into the dictionary. Stores the 8-bit value into the dictionary at the current dictionary pointer value, and increments the dictionary pointer by 1.

C/L -- n

Returns the number of characters per line (64) in a block of source code.
"c slash l"

C@ addr -- char

Returns the 8-bit value char located at addr. "c-fetch"

CARTESIAN -- addr

Returns the address of the Cartesian coordinate flag. When this flag is true (on), coordinates are interpreted in Cartesian coordinates (positive y up). When flag is false (off), QuickDraw coordinates (negative y up) are used. Refer to the Graphics Results chapter for a complete discussion of this feature.

CASE n -- n

Marks the beginning of a case statement. Used in the form:

```
CASE     X OF ... ENDOF
         Y OF ... ENDOF
ENDCASE
```

CENTER ---

Sets the graphics XYOFFSET to 1/2 MAX.X , 1/2 MAX.Y, the center of the current window.

CHARWIDTH char -- width

Returns the width (in pixels) for the specified character in the current text font.

CHECK.BOX n1\n2\n3\n4\n5 --

Check box control definition word. Refer to MacFORTH Level 2 Controls documentation.

CIRCLE x\y\radius\[pattern addr]\mode --

Draws a circle of radius at XY within current window according to mode. The pattern addr is neccessary for PATTERN mode only.

CLEAR -- 2

QuickDraw fill mode that specifies using the background pattern to fill the specified shape.

CLIP>CONTENT wptr --

Clips all drawing in the specified window to the content region. Controls will not be updated. Refer to NO.CLIP .

CLOSE file# --

Closes the specified file.

CLOSE.ALL ---

Closes all files.

CLOSE.BOX -- n

Constant containing bit mask for close box attribute in window attribute field.

CLOSE.WINDOW wptr --

Closes the window specified by wptr. All window-related heap data structures are returned to the heap and the specified window is removed from window linked list. You cannot close SYS.WINDOW, use HIDE.WINDOW to hide the MacFORTH window.

CMOVE src addr\dest addr\cnt --

Moves cnt bytes from src addr to dest addr. The transfer begins in low memory and moves toward high memory (ie. the byte at src addr is moved to dest addr, then the byte at src addr+1 is moved to dest addr+1, etc.). Error if the count is less than one; the system drops the parameters from the stack and no movement occurs. "c-move"

CMOVE> src addr\dest addr\cnt --

Moves cnt bytes from src addr to dest addr. Starts at the end of the string and proceeds toward low memory. See CMOVE "c-move-up"

CNT -- addr

User variable containing the total count of characters transferred by TYPE or EXPECT. Immediately following execution of EXPECT, CNT contains the actual number of bytes received. "c-n-t"

CNTR -- addr

User variable containing the current count of characters to be transferred. This number counts toward 0 for both input and output operations. "c-n-t-r"

COL -- addr

User variable containing the current output column position. "col"

COMMAND.KEY -- n

Constant event code returned by DO.EVENTS when a menu item is selected from the keyboard.

COMPILE ---

Used to compile the token for a word into the dictionary. When a word containing COMPILE is executed, the token for the word following COMPILE in the defintion is compiled into the dictionary. An unchecked error exists if the word following COMPILE is not found in the dictionary or convertible to a number.

COMPILING -- flag

Returns a true flag if STATE is non-zero. STATE = non-zero indicates compilation mode, STATE = zero indicates execution mode.

CONDENSED -- 32

Constant bit mask for condensed text attribute.

CONFIGURE.PRINTER *stop bits\parity\* data bits\ baud rate --

Used to custom configure the printer port for non-Imagewriter printers. Refer to the Printer chapter for more information.

CONSOLE -- addr

User variable containing the address of the current console device table.

CONSTANT n --

Creates a constant with value n. A defining word used in the form:

    n CONSTANT <name>

to create a dictionary entry for <name>, which when later executed will leave n on the top of the stack. n is compiled into the pfa of <name>.
See)CONSTANT

CONTEXT -- addr

User variable containing the handle for the vocabulary where dictionary searches are to begin during interpretation of the input stream.

CONVERT n1\addr1 -- n2\addr2

Converts the ASCII string at addr1+1 to its binary equivalent. The number is accumulated into n1 and returned as n2. Addr2 is the address of the first unconvertible character. See NUMBER <# # #S #> HOLD

COPY src blk#\dest blk# --

Copies src blk# into dest blk# in the current blocks file.

COS angle -- cosine * 10000

Returns integer cosine of angle * 10000 (4 digits of precision).

COUNT addr -- addr+1\cnt

Returns the address and count of the text string at addr+1. The count byte is at addr and text is at addr+1 on. The range of n is 0 - 255.

CR ---

Emits a CR LF to the current output device. "c-r"

CREATE ---

A defining word to create a dictionary entry for the name given. Used in the form:

```
CREATE <name>
```

to create a dictionary entry for <name>, allocating 2 bytes for the token. When <name> is later executed, the address of <name>'s parameter field is left on the stack. If the UNIQUE.MSG is on (true) and the word already exists in the CONTEXT or TRUNK vocabularies, the message "ISN'T UNIQUE" is displayed. See UNIQUE.MSG

CREATE.BLOCKS.FILE file# --

Creates the specified file as a blocks file on disc. The file is specified as a MacFORTH blocks file and can be loaded from the Finder.

CREATE.FILE file# --

Creates the specified file as a data file on disc.

CRLF -- addr

Returns the address of a literal string containing a CRLF sequence. Used in the form:

```
CRLF 2 TYPE
```

to output a CR LF sequence. See CR. "c-r-l-f"

CSP -- addr

User variable which temporarily holds the value of the stack pointer during compilation for error checking. "c-s-p"

CURRENT -- addr

User variable which contains the handle for the vocabulary into which newly created words are appended. This is the second vocabulary to be searched during a dictionary search (after CONTEXT).

CURRENT-FILE -- addr

Scratch variable used in the file system operators.

CURRENT.POSITION file# -- current file position

Returns the current position of the file pointer for the specified file.

CURSOR -- addr

Variable containing the address of the current cursor array.

CURSOR.CHAR -- addr

Variable containing the text font for the cursor symbol in the first 16-bits and the character code for the symbol in the second 16-bits.

DAYS> #days since 01/01/04 -- year\days\month

Converts the number of days since 01/01/04 to days to year, days, month since 01/01/04.

DEALLOT token --

Deallots object space for and above the specified token.

DEBUG -- addr

User Variable containing the flag which indicates the debug mode. When DEBUG is on (true), items left on the stack during execution are displayed with .S and words being executed have their name and stack implications displayed, if they where compiled with TRACE mode set. See TRACE and the Advanced Topics chapter.

DEBUG.ONLY ---

Exits the current definition if **DEBUG** is zero.

DECIMAL ---

Set the I/O numeric conversion base to decimal. See BASE .

DEFAULT.ACTIVATE --

Default activate function for all defined windows. Beeps on activate, (mouse down) nothing on deactivate.

DEFINITIONS ---

Determines the vocabulary new definitions are compiled in. Sets CURRENT to the CONTEXT vocabulary so that subsequent definitions will be created in the vocabulary previously selected as CONTEXT.

DELETE file# --

Deletes the specified file from disc.

DELETE.BLOCKS #blocks\file# --

Primitive used by APPEND.BLOCKS to delete blocks from a blocks file.

DELETE.MENU menu id --

Deletes the specified menu from the menu bar and redraws the menu bar.

DEPTH -- n

Returns the number of stack items (32-bit values) currently on the stack (before n was added).

DEVICE.CONTROL parm1\parm2\cmd\fcb --

```
Primitive device controlling word.
Stores:  16 Bit CMD    at FCB+26
         32 Bit PARM1 at FCB+28
         32 Bit PARM2 at FCB+32
          0            at FCB+36
Issues:  OS CONTROL TRAP with FCB .
```

DEVICE.STATUS cmd\fcb -- parm1\parm2

```
Primitive device status word.
Stores:   16 Bit CMD at FCB+26
Issues:   OS STATUS TRAP with FCB
Fetches:  16 Bit PARM1 from FCB+32
          32 Bit PARM2 from FCB+28
```

DFLT.CONTROL ---

Default word used to handle control characters on input and output for special console devices.

DFLT.WINDOW.TAIL -- addr

Array containing the default values for the MacFORTH extension to the standard window record.

DIGIT char\base -- [n\true] or [false]

Converts the ASCII character char, using the base given, to its binary equivalent. If the conversion was valid, n is left as the binary equivalent under a true flag, otherwise only a false flag is returned.

DIR drive # --

Displays the catalog for the media in the specified drive.
See INTERNAL EXTERNAL

DIRECTORY -- addr

Returns the address of the user variable which contains the disc directory load screen. Currently not used.

DISCARD.UPDATES --

Discards any pending update events for the current window. Used to eliminate double flash at window activation if ACTIVATE code redraws the window contents anyway.

DISK -- addr

Multitasking stub for source compatibility with future products.

DISK.EVENT -- n

Constant event code returned by DO.EVENTS on a disk inserted event.

DISPOSE.CONTROL n --

Disposes control. Unsupported in Level 1. Refer to MacFORTH Level 2 Controls documentation.

DKGRAY -- addr

Returns the address of the dark grey pattern.

DO upper limit\lower limit --

Marks the beginning of a finite loop structure. Used in a colon definition in the form:

```
  DO ... LOOP     or     DO ... n +LOOP
```

Begins a loop which will terminate based on the upper and lower limits given. DO .. LOOP's may be nested as long as each DO is matched with a corresponding LOOP or +LOOP within the same colon definition. The error message "DEFINITION INCOMPLETE !" indicates a DO was not matched with a corresponding LOOP or +LOOP . See LOOP and +LOOP .

DO.EVENTS -- event code

Removes the next event from the event queue. Executes any supplied default token in the events list, and returns the event code.

DOES> ---

Defines the run-time action within a high-level defining word. Used in the form:

```
  : <name>  ...  CREATE  ...  DOES> ... ;
```

It marks the termination of the defining part of the defining word <name> and begins the definition of the run-time action for words that will later be defined by <name>. On execution of a word defined by <name>, the words between DOES> and ; will be executed, with the parameter field address of the new word on the stack. "does"

DOT (x\y --)

Draws a dot at (x,y). Pen pattern, size, and mode determines effect on dots below and to the right of (x,y). The point is rotated, scaled and translated within the window according to the values in XYPIVOT, XYSCALE and XYOFFSET.

DOWN.BUTTON -- part code

Constant containing the part code for a mouse button down part code. Refer to MacFORTH Level 2 Controls documentation.

DP -- addr

User variable containing the current value of the dictionary pointer. This value may be read using HERE and altered using ALLOT . See HERE and ALLOT . "d-p"

DPL -- addr

User variable containing the number of places after the decimal point for numeric input conversion.

DRAW.CHAR char --

Draws char at the current pen position with the current text transfer mode in the current textstyle textfont and textsize. See EMIT

DRAW.CONTROLS wptr --

Draws controls associated with the specified window. Refer to MacFORTH Level 2 Controls documentation.

DRAW.MENU.BAR --

Redraws the menu bar from the current menu list. Execute this word after adding or deleting items to or from the menu list.

DRAW.TO x\y --

Draws to the supplied (x,y) coordinate. Dots to the right and below the pen are modified according to the current pen size, shape, pattern, and mode.

DRAWSTRING addr --

Draws string at addr with count in first position at current pen position according to the current text style, mode, size and font.

DROP n --

Drops the top stack item.

DRVR.EVENT -- n

Constant event code returned by DO.EVENTS on a DRIVER event

DUP n -- n\n

Duplicates the top stack item. "dupe"

DUP>R n -- n

Duplicates the top item on the stack and places it on the top of the return stack.

EJECT drive# --

Ejects media in drive. See INTERNAL EXTERNAL

ELSE ---

Marks the beginning of the "else portion" of a conditional structure. Used in a colon-definition in the form:

```
IF ... ELSE ... THEN
```

If the conditional for the IF is true, when the ELSE is encountered, it passes control to the word following THEN . If the conditional for the IF is false, control is passed to the word following ELSE. The error message "DEFINITION INCOMPLETE !" indicates the control structure was missing its THEN . The error message "CONDITIONALS NOT PAIRED" indicates the control structure was missing its IF .

EMIT char --

Outputs char. See DRAWCHAR

EMPTY ---

Removes all words and vocabularies above the currently specified task-dependent FENCE from the dictionary.
See (FORGET), FENCE , SET.FENCE

EMPTY-BUFFERS --

Clears the contents of the disc buffers, marking all buffers as unused.

ENCLOSE addr\delim -- addr\offset1\offset2\offset3

Text parsing primitive. Given an address to parse from and a delimiter, this operator skips over leading delimiters returning the address under offset to the first non-delimiter (offset1), under the offset to the last non-delimiter (offset2), under the offset to the following delimiter (offset3). The enclosed test starts at addr+offset2. Parsing for the next word should begin at addr+offset3. A null (zero) character always acts as a delimiter regardless of the specified delimiter.

ENDCASE n --

Terminates a case statement. Used in the form:

```
CASE     X OF ... ENDOF
ENDCASE
```

Completes the case statement by dropping n and resolving all unresolved branch addresses (left on the stack by ENDOF) to pointer after ENDCASE .

ENDOF ---

Terminates a conditional within a case statement. Used in the form:

```
CASE
  X OF ... ENDOF
ENDCASE
```

If the OF portion of the statement is true, ENDOF branches to the first instruction after ENDCASE. See CASE OF ENDCASE

ENTER.FLAG -- addr

Variable containing the enter key flag. This flag is set when the enter key is used to terminate a line of input. The user is responsible for clearing and checking this flag. It is set by EXPECT .

ERASE addr\n

Zero fills memory at addr for n bytes. If n is less than or equal to zero, take no action. See FILL BLANKS

ERASE.RECT address --

Fills the contents of rectangle at address with the current background pattern. The rectangle is 4 16-bit values representing the top, left, bottom, and right sides.

ERROR addr\cnt --

Executes the token contained in the user variable (ERROR). Addr and cnt point to a string to be output. See (ERROR) , ((ERROR)) , (ERROR") , and ERROR" .

ERROR" flag --

Aborts the current task, displays the name of the word executed and the supplied message if flag is true. Used in the form:

```
ERROR" <user error message>"
```

Compiles (ERROR") followed by the inline literal string. If flag is true when (ERROR") executes, the name field of the most recently interpreted word (in POCKET) is displayed, followed by the string <user error message>, finally the system ABORTs, returning control to the console. If flag is false, control is passed to the word following the string literal. "error-quote"

EVENT.LOOP --

Default loop which dispatches to the next active window. If all windows are deactivated, this word executes DO.EVENTS until a window activate event occurs.

EVENT.RECORD -- addr

Array containing the event record for the current event.

```
bytes:  0- 1  contain the event code
        2- 5  contain the event message
        6- 9  contain the mouse
       10-13  contain the time in ticks when the event occured
       14-15  contain the modifiers bits (kbd state)
```

EVENT.TABLE -- addr

Array containing default tokens to be executed for each of the 24 standard events. DO.EVENTS always executes this token whenever the appropriate event occurs. The caller to DO.EVENTS is also notified with an event code.

EVENTS -- addr

Returns the address of the variable containing the mask for all events.

```
EVENTS  OFF
```

Disables all events. No events are enabled when DO.EVENTS is called.

```
EVENTS  ON
```

Enables all events.

NOTE: If a keystroke is waiting in the keystroke array, the contents of EVENTS is ended with the constant -KEYBOARD , effectively disabling keyboard events until the keyboard data is read. This allows for type ahead.

EXECUTE token --

Execute the dictionary entry whose token is on the stack.

EXIT ---

Terminates execution of a definition. When compiled into a colon definition, causes the word to terminate at that point when later executed. An unchecked error exists if used within a DO .. LOOP structure or a >R ... R> pair.

EXPECT addr\max cnt --

Accepts up to max cnt characters from the terminal and stores them at addr. Input terminates on receipt of either a carriage return or max cnt characters. No action is taken for max cnt less than one. The user variable CNT is set to the actual number of charaters received.

EXTENDED -- 64

Constant bit mask for extended text attribute.

EXTERNAL -- 2

Constant drive number for the external drive. Use with EJECT , DIR

FALSE -- 0

Boolean false constant.

FCB.LEN -- n

Constant containing the length of a file control block.

FENCE -- addr

Returns the address containing a pointer below which FORGETting is prevented. to FORGET below this point, alter the value in fence or use: NO.FENCE . Note: FENCE is set by the system to prevent FORGETting of interrupt handlers and vectored words so use caution when changing its value. See SET.FENCE FORGET NO.FENCE

FIELD n --

MacFORTH field defining word. Creates a 16-bit constant which will add itself to the word on the top of the stack when executed. Used in the form:

```
   n  FIELD  <field name>
```

to create a field definition <field name> which, when later executed will add n to the value on the top of the stack.

FILE.ERROR.MSGS -- addr

String array containing file/os error messages.

FILE.TYPE file.type\file#

Sets the file type for the file. For example:

```
    "TEXT  1  FILE.TYPE
```

would set file number 1 to a text file type.
See "TEXT "DATA "4TH "PICT

FILL addr\cnt\char --

Fills memory at addr for cnt bytes with char. No action taken for cnt less than one.

FIND -- [token] or [0]

Returns the token for the next word in the input stream. If that word cannot be found in the dictionary after a search of CONTEXT or TRUNK vocabularies, returns a zero.

FIND.CONTROL point\wptr -- [control.handle\control part code] or [0]

Given a point (in local window coordinates) and window pointer, if the point is within a control region for the window, returns the control handle and part code of the control. If the point does not lie witin a control region, a zero is returned. The available part codes are (refer to their glossary entries for more information):

```
IN.BUTTON     IN.CHECKBOX     UP.BUTTON     DOWN.BUTTON
PAGE.UP       PAGE.DOWN       IN.THUMB
```

As with other controls, this information is more completely documented in MacFORTH Level 2 Controls documentation.

FIND.WINDOW point -- wptr\window part code

Given a point (in global coordinates), returns the window pointer and part code for the window. The window part codes are one of the following:

Location	Window Part Code
desktop	0
menu bar	1
system window	2
content region of active window	3
drag region of active window	4
grow box of active window	5
close box of active window	6

FIRST -- addr

Returns the address of the first block buffer.

FLUSH ---

Writes all blocks that have been UPDATEd to mass storage. Identifies all blocks as 7FFFFFFF (hex) to force any new block to be re-read from mass storage.

FLUSH.EVENTS --

Flushes all pending events from the event queue.

FLUSH.FILE file# --

Writes the file control block of the specified file out to disc.

FLUSH.VOL volume # --

Writes the volume information for the specified volume (use the file number of any file on the desired volume) out to disc.

FMT.DATE$ *days\flag -- addr\cnt

Formats a date string for output. The date formatted is in terms of *days since 01/01/04. If the flag is true the month, day and year are separated by slashed ("/"). The formatted string is placed at addr for cnt bytes.

FMT.TIME$ addr --

Formats the time output string at addr in the following format:

```
HH:MM:SS XM
```

FOLLOWER -- addr

Multitasking stub used for compatibility with future products.

FORGET ---

Removes entries from the dictionary. Used in the form:

```
FORGET <name>
```

to delete all entries added after and including <name> from the dictionary (in the CONTEXT vocabulary). Forgotten Menus or windows are removed from their respective lists and purged from the display. If <name> is not found in the CONTEXT or TRUNK vocabularies, an error message is issued (<name> is displayed followed by "?"). FORGETting is terminated at the FENCE. See SET.FENCE EMPTY NO.FENCE

FORTH ---

The name of the primary vocabulary. When executed, FORTH becomes the CONTEXT vocabulary.

FRAME -- 0

QuickDraw shape mode attribute. Shape will be drawn in outline mode.

FROM.CURRENT -- position mode

Constant used to indicate that file positioning should be done relative to the current file position.

FROM.END -- position mode

Constant used to indicate that file positioning should be done relative to the end of the file.

FROM.HEAP size -- handle

Requests the memory manager to allocate a relocatable data structure in the heap of size bytes. The handle returned is non-zero if successful and contains the address of a pointer to the allocated data structure. The contents of the handle changes dynamically with the heap, however the address of the handle will never change. Refer to the Apple Developer's documentation for further details. Reference: NewHandle. See also: IN.HEAP, TO.HEAP, RESIZE.HANDLE

FROM.START -- position mode

Constant used to indicate that file positioning should be done relative to the start of the file.

FRONT.WINDOW -- wptr

Returns wptr to currently active (or front) window.

FUNC>L n --

Defining word used to for function calls to the Macintosh toolbox. Refer to the Advanced Topics Toolbox Interface section.

FUNC>W n --

Defining word used to for function calls to the Macintosh toolbox. Refer to the Advanced Topics Toolbox Interface section.

GET addr --

Multitasking stub for source compatibility with future products.

GET.CONTROL n -- n

Not supported in Level 1. Refer to MacFORTH Level 2 Controls documentation.

GET.CURSOR --

Returns the address of the cursor in use (0 indicates default NW arrow).

GET.DATE$ addr --

Formats the current date into a string in the format MM/DD/YY and places it at addr.

GET.EOF file# -- #bytes

Returns the number of bytes in the specified file (its end of file pointer).

GET.FILE.INFO file# --

Reads the file information from disc for the specified file. The information is read into the files FCB.

GET.FILE.TYPE file# -- file type

Returns the file type of the specified file.

GET.ICON res id -- handle

Reads the ICON specified by res id from the resource file. The handle to the ICON is returned. See PLOT.ICON .

GET.ITEM menu handle\item#\$ addr --

Returns text for the specified menu item at $ addr.

GET.LINE.HEIGHT -- line height

Returns the line height for the current window. See the Graphics Results chapter.

GET.PICTURE res id -- handle

Reads the picture specified by res id from the resource file, returning its handle.

GET.PIXEL (x\y -- flag)

Returns TRUE if the pixel at (x,y) in the current window is on. The specified (x,y) position must be in QuickDraw coordinates.

GET.REC.LEN file# -- rec len

Returns the fixed record length of the fixed file specified by file#. If the specified file is not a fixed file type, the rec len returned will be an arbitrary value.

GET.SCRAP handle\res type -- io result

Fetches the contents of the desk scrap specified by res type to handle. If the io result is zero, the contents were fetched successfully.

GET.TEXTFONT -- font#

Returns text font number for current window. See the Graphics Results chapter.

GET.TEXTMODE -- mode

Returns text mode for current window. See the Graphics Results chapter.

GET.TEXTSIZE -- text size

Returns current text size. See the Graphics Results chapter.

GET.TEXTSTYLE -- style bits

Returns text style bits for the current window. See the Graphics Results chapter.

GET.TIME$ addr --

Stores the formatted time string (in the format HH:MM:SS XM) at addr.

GET.WINDOW -- wptr

Returns the window pointer of the currently active window.

GET.XYOFFSET -- x\y

Returns the offset in QuickDraw coordinates to the origin (0,0) of the current window.

GET.XYPIVOT -- angle

Returns the current XYPIVOT angle for the current window.

GET.XYSCALE -- x scale\y scale

Returns the X and Y scale factors for the current window.

GINIT ---

Initializes graphics parameters for the current window. The following defaults are set:

```
 XYPOS --> XYBIAS  erased
 100  100  XYSCALE
 0 XYPIVOT
12 TEXTSIZE
15  LINE.HEIGHT
11 PENSIZE BLACK  PENPAT
0  0   XYOFFSET
0 0 MOVE.TO
```

GLOBAL>LOCAL point (global) -- point (local)

Converts a point in global coordinates to a point in local coordinates for the currently active window.

GRAY -- addr

Returns the address of the gray pattern.

HANDLE.SIZE handle -- size

Returns the size of a relocatable data structure in the heap.
Reference APDEVDOC: GetHandleSize

HANDLER -- addr

Multitasking stub maintained for compatibility with future products.

HBAR.BOUNDS wptr -- t\l\b\r

Returns rectangle for horizontal scroll box within window. Refer to MacFORTH Level 2 Controls documentation.

HERE -- addr

Returns the address pointed to by the dictionary pointer. It is the next available memory location in the dictionary.

HEX ---

Sets the current numeric I/O base to hexadecimal.

HIDE.CURSOR --

Hides the cursor. Increments the cursor level, which is decremented by SHOW.CURSOR. When the cursor level is 0, the cursor is visible. Use INIT.CURSOR to reset the cursor level.
See INIT.CURSOR SHOW.CURSOR

HIDE.PEN ---

Hides the pen. Decrements the pen level in the current graphport, which is incremented by SHOW.PEN.
See SHOW.PEN

HIDE.WINDOW wptr --

Hides the specified window. Clears the visible flag in the window record, and the window disappears from the screen.

HILITE.CONTROL n1\n2 --

Refer to MacFORTH Level 2 Controls Documentation.

HILITE.MENU n --

Highlight menu n . Where n is an invalid menu id (like 0), no menus are highlighted. Normally used to turn off menu highlight which is automatically done when a menu item is selected.

HILITE.WINDOW flag\wptr --

Window primitive. Hilights the specified window based on flag.

HLD -- addr

User variable which holds the address of the latest character of text during numeric output conversion. "h-l-d"

HOLD char --

Inserts char into a pictured numeric output string. May only be used between <# and #> . An unchecked error occurs when used outside <# and #> . See <# and #> .

HUSH ---

Immediately terminates any sound being produced by the sound driver.

I -- n

Copies the loop index (maintained on the top of the return stack) onto the data stack. Must be used only within a DO ... LOOP structure. Unchecked error occurs if used outside a DO ... LOOP or DO ... +LOOP structure. **Warning:** If you use **R>** or **>R** inside a loop, the loop indices may be altered.

I! n --

Stores n at the address corresponding to the current value of the loop index. "i-store"

I+ n -- n+(loop index)

Increments the top of the stack by the current loop index.

I+! n\offset --

Equivalent to I + !

I+@ offset -- n

Equivalent to I + @

I+W! n\offset --

Equivalent to I + W!

I+W@ offset -- n

Equivalent to I + W@

I- n -- n-(loop index)

Decrements the top of the stack by the current loop index.

I@ -- n

Fetches n from the address corresponding to the current value of the loop index. "i-fetch"

IBEAM -- addr

Returns the address of the i-beam cursor array.

IC! char --

Stores char (using C!) at the address corresponding to the current value of the loop index. "i-c-store"

IC@ -- char

Fetches char (using C@) from the address corresponding to the current value of the loop index. "i-c-fetch"

ID. nfa --

Prints the name field of the definition whose nfa is given. "i-d-dot"

IF flag --

Marks the beginning of the "true portion" of a conditional structure. Used in a colon definition in the form:

IF ... THEN

or

IF ... ELSE ... THEN

If flag is true, the words following IF until the ELSE (if present) or THEN (if ELSE is not present) are executed. If flag is false, control is passed to the words following ELSE (if present) or THEN (if ELSE is not present). The error message "DEFINITION INCOMPLETE !" indicates the IF was not matched with a THEN . See ELSE and THEN .

IFEND ---

Marks the end of an executable conditional structure. Executed in the form:

IFTRUE ... OTHERWISE ... IFEND or IFTRUE ... IFEND

Execution version of the compiled IF ... ELSE ... THEN structure. This word is used as a marker for IFTRUE and OTHERWISE and if executed does nothing. See IFTRUE and OTHERWISE . "if-end"

IFTRUE flag --

Marks the beginning of the "true portion" of an executable conditional structure. Executed in the form:

IFTRUE ... OTHERWISE ... IFEND or IFTRUE ... IFEND

Execution version of the compiled IF ... ELSE ... THEN structure. IFTRUE performs the execution version of IF in the compiled version. If flag is true, the words following IFTRUE up to the OTHERWISE (if present) or IFEND (if OTHERWISE is not present) are executed. If flag is false, control is passed to the words following OTHERWISE (if present) or IFEND (if OTHERWISE is not present). The error message "MISSING OTHERWISE OR IFEND" implies the input stream was exhausted before an OTHERWISE or IFEND was encountered. See IFEND and OTHERWISE .

ILLEGAL.FILE ---

Displays the message "Illegal File*" and aborts the current task.

IMMEDIATE ---

Marks the most recently defined word as "immediate". The word will be executed when encountered during compilation rather than compiled into the dictionary.

IN.BUTTON -- n

Refer to MacFORTH Level 2 Controls Documentation.

IN.CHECKBOX -- n

Refer to MacFORTH Level 2 Controls Documentation.

IN.CLOSE.BOX -- n

Constant event code returned by DO.EVENTS when a mouse down occurs in the close box of the currently active window.

IN.DESKTOP -- n

Constant event code returned by DO.EVENTS when a mouse down occurs on the desktop.

IN.DRAG.BOX -- n

Constant event code returned by DO.EVENTS when a mouse down occurs in the drag region of a window.

IN.HEAP ---

Marks the latest word as containing a heap handle in its parameter field. When the word is later forgotten, the handle will be automatically returned to the heap.

IN.LOWER.WINDOW -- n

Constant event code returned by DO.EVENTS when a mouse down occurs in a non active window.

IN.MENUBAR -- n

Constant event.code returned by DO.EVENTS when a mouse down occurs in the menu bar.

IN.SIZE.BOX -- n

Constant event code returned by DO.EVENTS when a mouse down occurs in the size box of the currently active window.

IN.SYS.WINDOW -- n

Constant event code returned by DO.EVENTS when a mouse down event occurs in a system (desk accessory) window.

IN.THUMB -- n

Refer to Level 2 Controls Documentation.

INCLUDE" ---

Used in the form:

```
INCLUDE" <blocks file name>"
```

to include (load) the contents of the specified blocks file, by loading the first block in the file.

INDEX first block#\last block# --

Displays the first line of each block over the range given. The first line of each block should be a comment describing the contents of that block.

INIT.CURSOR --

Resets the cursor level to 0 and displays the default northwest arrow cursor. See HIDE.CURSOR SHOW.CURSOR

INITIALS -- addr

User variable containing the user's initials.

INPUT.NUMBER width -- [n\true] or [false]

Inputs a number of up to the width specified. If nothing is entered (the operator just pressed return), a false flag is returned. If a number is entered, the number is returned under a true flag. Invalid characters (non 0-9 or "-"), terminate number conversion when encountered.

INPUT.STRING addr\cnt --

Inputs a string to a string variable (or any address). After the string has been input, the number of characters entered is stored at addr, the string at addr+1 on.

INTERNAL -- 1

Constant drive number for the internal drive.

INTERPRET ---

Executes 'INTERPRET . You may use an alternate text interpreter (for example, one that accepts floating point numbers) by storing the token of your new interpretation word into the pfa of INTERPRET . The actual definition of INTERPRET is simply:

```
 : INTERPRET  'INTERPRET  ;
```

INVALID.RECT addr --

Marks the rectangle at addr within the current window as not requiring updates.

INVERT -- n

QuickDraw shape mode attribute shape will be drawn with all bits inverted in the destination.

IO-RESULT -- addr

Variable containing the I/O result code of a file operation.

ITALIC -- n

Constant bit mask for italic text attribute.

ITEM$ -- addr

Returns the address of the 32-byte array used by MacFORTH to manipulate item strings such as desk accessories.

ITEM.CHECK item\check.flag\menu id --

Sets or clears the check mark associated with the specified menu item.

ITEM.ENABLE item\flag\menu id --

Enables or disables the specified menu item. Disabled items cannot be selected.

ITEM.ICON item\icon\menu id --

Displays the selected icon with the specified menu item.

ITEM.MARK item\mark\menu id --

Attaches a mark (like a check mark or apple) to associate with the specified menu item.

ITEM.STYLE item\style char\menu id

Selects the text style for the specified menu item from style character. Refer to the Menu chapter for a listing of style characters.

J -- n

Returns the index of the next outer finite loop construct. May used only within a nested DO .. LOOP (or DO .. +LOOP). An unchecked error occurs if used outside a DO ... LOOP or DO ... +LOOP structure.

KEY -- char

Returns the ASCII value of the next available character from the current input device. Waits until a key is pressed if no keystroke is waiting in the type ahead buffer.
** Note ** Return (CR) and Backspace (BS) are ignored.
See ?KEYSTROKE

KEY.DOWN -- n

Constant event code returned by DO.EVENTS on a key down event.

KEY.STROKE -- addr

Array containing the event record for the most recent keystroke. A two byte filler is added to the front of the record so that the first four bytes may be used as a flag.
See EVENT.RECORD for the field layout

KEY.UP -- n

Constant event code returned by DO.EVENTS on a key up event

KILL.CONTROLS wptr --

Refer to MacFORTH Level 2 Controls Documentation.

KILL.IO buf ptr --

Aborts any pending i/o transaction on device associated with buf ptr.

L>FUNC>L n --

Defining word used to access Macintosh function calls. Refer to the Advanced Topics chapter.

L>FUNC>W n --

Defining word used to access Macintosh function calls. Refer to the Advanced Topics chapter.

LAST.TOKEN -- addr

Variable containing the negative token table offset to the most recently allocated token. The least significant 16-bits of this variable are actually the value of the latest token. **LAST.TOKEN** - 4 is a variable containing the maximum negative token table offset.

LATEST -- nfa

Returns the nfa of the most recently defined word in the CURRENT vocabulary.

LEAVE ---

Forces termination of a finite loop structure at the next LOOP or +LOOP. Sets the loop limit equal to the current value of the index. The index itself remains unchanged and execution proceeds normally until the loop terminating word (LOOP or +LOOP) is encountered. An unchecked error occurs if used outside of a DO ... LOOP or DO ... +LOOP with unpredictable results.

LIMIT -- addr

Returns the address just above the highest memory available for a disc buffer. This is usually the highest system memory.

LINE# -- addr

User variable containing the number of lines output. This variable is incremented by CR and set to zero by PAGE Useful for page formatting.

LINE.HEIGHT n --

Sets line height to n.

LIST block# --

Lists the contents of the given block number. The value in OFFSET is taken into account. See OFFSET .

LIT -- n

Places the compiled number following it on the stack. Within a colon definition, LIT is automatically compiled before each literal number encountered in the input stream. Later execution of LIT causes that number to be placed on the stack. If LIT is compiled, the following 32-bit value (usually a compiled cfa) will be pushed on the data stack at run time.

LITERAL n --

If compiling, compile n as a literal number, which when later executed takes the number off of the data stack at compile time. For example, to compile the number of the current block, you could execute:

```
[ BLK @ ]  LITERAL
```

This would return the block number that the definition was compiled into at run time.

LMOVE addr1\addr2\cnt --

Moves cnt 32-bit words from address1 to address2. See CMOVE

LMOVE> src addr\dest addr\cnt --

Moves cnt long words (32-bit, 4 byte) from src addr to dest addr. Starts at the end of the array and proceeds towards low memory.
See CMOVE> "move-up"

LOAD block# --

Interprets the contents of block#. Begins interpretation of the block number given by making it the input stream and preserving the current contents of >IN and BLK . If interpretation is not terminated explicitly, it will be terminated when the input stream is exhausted. Control then returns to the input stream containing LOAD , determined by the input stream locators >IN and BLK . The value in the user variable OFFSET is added to the block# given. Error if the specified block cannot be loaded from mass storage. See BLOCK , >IN , BLK , and OFFSET .

LOAD.SCRAP -- io result

Loads the clipboard file from the system disc into the desk scrap memory.

LOCAL>GLOBAL point (local) -- point (global)

Converts point in coordinates local in the currently active window to global screen coordinates.

LOCK.FILE file# --

Locks the specified file.

LOCK.FONT font# --

Locks the specified font in memory. Will not be lost on heap compression.

LOCK.HANDLE handle --

Marks the specified handle as locked. See Apple Developer's documentation for further details. Reference: HLock

LOOP ---

Terminates a finite loop structure. Used in the form:

DO ... LOOP

Increments the DO ... LOOP index by one, terminating the loop if the new index is equal to or greater than the loop limit. The error message "CONDITIONALS NOT PAIRED" indicates the LOOP was not preceded by a matching DO . See DO and +LOOP .

LOWER.CASE -- addr

User variable containing a flag which, when true, causes FIND to convert all interpreted strings to upper case.

LOWER.LEFT ---

Sets the graphics XYOFFSET to the lower left corner of the current window.

LTGRAY -- addr

Returns the address of the light gray pen pattern.

M* n1\n2 -- d

Returns the signed 64-bit product of the two signed 32-bit numbers given. "m-star"

M/MOD d\n -- remainder\quotient

Divides the 64-bit number d by the 32-bit number n, returning the 32-bit signed remainder and quotient. "m-divide-mod"

MAC.CON -- addr

Array containing console device i/o vectors for Macintosh console. See CONSOLE

MAC.CONSOLE --

Sets Macintosh console as default console device.
See MAC.CON CONSOLE

MAC.FILES ---

Sets the file read/write operator for blocks to MAC.R/W.
See MAC.R/W, (R/W)

MAC.R/W addr\block#\flag --

Primitive used for blocks file I/O. Standard Macintosh block file read/write primitive. If flag is non-zero, Block is read to address, if flag is zero, block is written from address.

MAKE.RECT x1\y1\x2\y2 -- xy\xy\ addr

Compresses XY coordinate pairs into a TLBR rectangle. The address of the rectangle within the stack is left on the stack.

MAKE.TOKEN addr -- token

Converts the address on the stack to a 16-bit token. If the address is greater than NEXT.PTR+32k, a new entry is made in the token table, and the relative offset to the token table entry (below NEXT.PTR) is returned. All tokens are 16-bit values, Token table offsets are negative from NEXT.PTR. See NEXT.PTR, NEW.TOKEN, TOKEN>ADDRESS.

MASK.HANDLE handle -- addr

Converts the contents of a handle to an address by ANDing off the high-order byte (used for memory manager flags).

MATCH $\$ cnt\addr\cnt -- [0\addr+cnt+1] or [true\$+$ cnt+1]

String comparison routine to find a match on the string at $ (its address) for $ cnt bytes over the range addr for cnt bytes.

MAX n1\n2 -- n3

Leaves the maximum of n1 and n2. "max"

MAX.X -- x

Returns the maximum x-axis value of the content region of the current window in QuickDraw coordinates.

MAX.Y -- y

Returns the maximum y-axis value of the content region of the current window in QuickDraw coordinates.

MENU.ENABLE flag\menu id --

If menu is non-zero, the specified menu is enabled, otherwise it is disabled, and cannot be selected.

MENU.HANDLE menu id -- menu handle

Returns the menu handle for specified menu.

MENU.SELECTION: menu id --

Exits the current definition, placing the following address into the menus array at menu id*4. When the menu is later executed, control is passed to the following address.

MENUS -- addr

Array containing the addresses to execute for each of the possible active menus.

MIN n1\n2 -- n3

Leaves the minimum of n1 and n2. "min"

MINIMUM.OBJECT size --

If the current object size is less than the specified size, MacFORTH attempts to resize the object image to the specified size.
See RESIZE.OBJECT

MINIMUM.VOCAB size --

If the current vocabulary size is less than the specified size, MacFORTH attempts to resize the vocabulary image to the specified size.
See RESIZE.VOCAB

MOD n1\n2 -- n3

Returns the remainder of n1 divided by n2, with the same sign as n1. Error if division by zero (see */). "mod"

MONTHS -- addr

Table containing the number of days in each month.

MOUSE.BUTTON -- flag

Returns the state of the mouse button. True when down.

MOUSE.DOWN -- n

Constant event code returned by DO.EVENTS if a mouse down event occurs. See EVENT.RECORD for field layout.

MOUSE.DOWN.RECORD -- addr

Array containing the event record for the most recent mouse down event. A two byte filler is added to the record so that the first four bytes may be used as a flag. See EVENT.RECORD for field layout.

MOUSE.UP -- n

Constant event code returned by do.events if a mouse up event occurs. See EVENT.RECORD for field layout

MOUSE.UP.RECORD -- addr

Array containing the event record for the most recent mouse up event. a two byte filler has been added to the start of the record so that the first 4 bytes may be used as a flag. See EVENT.RECORD for field layout.

MOUSE.WAS.. -- point

Returns the point location of where the mouse last went down (in global coordinates). See @MOUSE.DN GLOBAL>LOCAL

MOVE.TO x\y --

Moves the pen to the supplied (x,y) position.

MT n --

Defining word to call Macintosh toolbox rooutines. Refer to the Advance Topics chapter.

MT>W n --

Defining word to call Macintosh toolbox rooutines. Refer to the Advance Topics chapter.

MUNGER handle\offset\addr1\cnt1\addr2\cnt2 -- result

Macintosh universal string operator. Refer to *Inside Macintosh*.

NEEDED (n --)

Aborts the current definition with the error message "Not Enough Stack Items!" if less than n items are on the stack.

NEGATE n -- -n

Returns the two's complement of n. Error if n is the most negative integer, system response is to return the same value given.

NETWORK.EVENT -- n

Constant event code returned by DO.EVENTS on a network event.

NEW.BLOCKS.FILE #blocks\file$ -- file#

Used in the form:

<size> " <file name>" NEW.BLOCKS.FILE

to create a new blocks file with the specified number of blocks and file name. If the file is successfully created, it is opened and selected as the current blocks file and its file number is returned on the stack.

NEW.FILE size\file$ -- file#

Used in the form:

<size> " <file name>" NEW.FILE

to create a new data file with the specified length and file name. If the file is successfully created, it is opened and its file number is returned on the stack.

NEW.MENU position\title$\menu id --

Defines a new menu and links it into menu list. Menu id must be in the range 0-31, title$ is the title for the menu, and position of 0 places item on the left, -1 on the right. See the Menu chapter for examples.

NEW.STRING str addr -- handle

Allocates new handle from heap for a string and copies the string into the handle. The handle of the string is returned on stack. Use IN.HEAP to tag any word defined with this handle in order to deallocate handle when word is forgotten.

NEW.TOKEN addr -- token

Converts addr on stack to an indirect token. An entry is made in the token table, and the negative relative address to NEXT.PTR of the token table entry is returned. Used by NEW.TOKEN to handle addresses > NEXT.PTR+32k.

NEW.WINDOW --

MacFORTH window defining word. Creates a named window record which will return its wptr when executed.

NEXT.FCB -- file#

Returns the file number for the next available file control block for assignment. Aborts with the error message "No FCBs Available!" if all FCBs are in use.

NEXT.PTR -- addr

Returns the address contained in the relocation base register A4.

NFA token -- nfa

Converts the token given to the nfa for the definition. "n-f-a"

NO.CLIP wptr --

Disables clipping within window bounds. Note that controls may only be drawn or updated if CLIP>CONTENT is active.

NO.ECHO -- addr

User Variable containing a flag which is used by EXPECT. When NO.ECHO is non-zero, EXPECT does not echo keystrokes to the console. QUIT resets this flag to the default cleared. Uses include: passwords,and fully intrepreted text fields (ie: left zero fill calculator type text entry) NO.ECHO ON disabled keystroke echo; NO.ECHO OFF echoes keystrokes in EXPECT.

NO.FENCE ---

Resets the fence to the top of the top of the current vocabulary.

NO.RETRY ---

Procedure which pops the recovery stack frame from the return stack. Pushed onto the return stack at the bottom of the recovery frame.

NON.PURGABLE handle --

Marks a relocatable heap data structure (a "handle") as non-purgable. See Apple Developer's documentation for further details: reference: HNoPurge

NOT flag -- -flag

Reverse the boolean value of the flag given. See 0= .

NOT.VISIBLE -- n

Constant bit mask for not visible window attribute.

NOTPATBIC -- n

Constant specifying bit transfer mode. The current pattern is complemented and used to clear corresponding bits in the destination.

NOTPATCOPY -- n

Constant specifying bit transfer mode. The current pattern is complemented and copied directly into the destination.

NOTPATOR -- n

Constant specifying bit transfer mode. The current pattern is complemented and Or'ed into the destination.

NOTPATXOR -- n

Constant specifying bit transfer mode. The current pattern is complemented and Exclusive Or'ed into the destination.

NOTSRCBIC -- n

Constant specifying bit transfer mode. The source pattern is complemented and used to clear corresponding bits in the destination.

NOTSRCCOPY -- n

Constant specifying bit transfer mode. The source pattern is complemented and copied directly to destination.

NOTSRCOR -- n

Constant specifying bit transfer mode. The source pattern is complemented and Or'ed with the destination.

NOTSRCXOR -- n

Constant specifying bit transfer mode. The source pattern is complemented and exclusive Or'ed with destination.

NULL.EVENT -- n

Constant event code. No events posted.

NUMBER addr -- n

Attempts to convert the string at addr+1 to a number. The character immediately following the numeric string <u>must</u> be an ASCII blank. If successful, n is returned, otherwise an error is generated indicating that the string was not recognized as a number in the current base.

OBJECT.FULL!! ---

Aborts with the error message "Object Full!" if the object area is full.

OBJECT.HANDLE -- addr

User variable which contains the address of the handle pointing to the base of the current object area. The object area is allocated from the heap and is set up as locked and nonpurgable. This area may be resized with the RESIZE.OBJECT operator as long as no other non-relocatable memory allocation has occured above this address.

OBJECT.ROOM -- # bytes

Returns number of bytes available in the current object space.

OF n1\n2 -- [n1] or []

Marks the beginning of a conditional branch within a case statement. Used in the form:

```
 CASE ...
   X OF ... ENDOF
 ENDCASE
```

If n1 is equal to n2, both arguments are dropped, and execution continues through ENDOF and then skips just past the next ENDCASE . If n1 is not equal to n2, n2 is dropped and execution continues after ENDOF.

OFF addr --

Stores a 32-bit zero at addr (eg. DEBUG OFF). See ON

OFF.CONTROL n --

Refer to Level 2 Controls Documentation.

OFFSET -- addr

User variable containing the block offset value. Used by BLOCK to determine the actual physical block number to be accessed. See BLOCK

ON addr --

Stores a 32-bit -1 at addr. See OFF

ON.ACTIVATE wptr --

Defines token to execute when window is activated. Used in the form:

```
 <wptr> ON.ACTIVATE <procedure>
```

When <procedure> is later invoked (as a result of the window becoming active) a flag is left on the stack. If the flag is true, it is an activate event, if false, it is a deactivate event.

ON.CONTROL n --

Refer to Level 2 Controls Documentation.

ON.ERROR ---

Establishes the recovery stack frame. Compiles (ON.ERROR) to establish this frame and branches over the recovery code past the delimiting RESUME . Used in the form:

```
ON.ERROR <recovery code>  RESUME
```

Refer to the Advanced Topics chapter for more information.

ON.UPDATE wptr --

Defines the token to be executed when an update event occurs for the specified window. Used in the form:

```
wptr  ON.UPDATE  xx
```

When an update event occurs, xx will be executed to perform any update action for the specified window.

OPEN file# --

Opens the specified file.

OPEN" -- file#

Used in the form:

```
OPEN" <file name>"
```

to open the specified file. If the file is opened successfully, the file number it is assigned to is returned on the stack.

OPEN.DA $ addr --

Opens the desk accessory whose name matches the supplied string.

OPEN.DEVICE name$\fcb --

Attempts to open the device named name$ using the specified fcb.

OPEN.PORT wptr --

Initializes the graphport at wptr.

OPEN.PRINTER ---

Opens the printer device driver.

OPEN.RSRC file# --

Opens the resource fork of the specified file.

OPEN.SOUND ---

Opens the sound device driver.

OPTIONS.MENU ---

Installs the MacFORTH "Options" menu on the menu bar. See APPLE.MENU

OR n1\n2 -- n3

Leave n3 as the bitwise inclusive-OR of n1 and n2.

OS.TRAP n --

Defining word used to access the Macintosh toolbox. Refer to the Advanced Topics chapter.

OTHERWISE ---

Marks the beginning of the "else portion" of an executable conditional structure. Used in the form

```
  IFTRUE ... OTHERWISE ... IFEND
```

Equivalent in control flow to ELSE in the compiled

```
  IF ... ELSE ... THEN
```

construct. See IFTRUE IFEND IF ELSE THEN

OUTLINE -- 08

Constant bit mask for outline text attribute.

OVAL x1\y1\x2\y2\[pattern addr]\mode --

Draws an oval within the rectangle (x1,y1,x2,y2) according to mode. Pattern addr is need if the mode is PATTERN.

OVER n1\n2 -- n1\n2\n1

Copy the second stack item over to the top of the stack.

PAD -- addr

Returns the address of a scratchpad area. Used to hold character strings for intermediate processing, as well as a scratchpad area for other tasks. The minimum capacity of PAD is 64 characters.

PAGE ---

Outputs a form feed to the current display devices. This clears the console display and ejects a page on any attached printers.

PAGE.DOWN -- n

Refer to MacFORTH Level 2 controls documentation.

PAGE.UP -- n

Refer to MacFORTH Level 2 controls documentation.

PAINT -- 1

QuickDraw shape mode attribute which specifies that the figure will be drawn filled with the current pen pattern.

PATBIC -- n

Constant specifying bit transfer mode. The current pattern is used to clear corresponding bits in the destination.

PATCOPY -- n

Constant specifying bit transfer mode. The current pattern is directly copied into the destination.

PATOR -- n

Constant specifying bit transfer mode. The currrent pattern is OR'ed into the destination.

PATTERN pattern -- pattern\4

QuickDraw shape mode attribute shape will be filed with supplied pattern.

PATXOR -- n

Constant specifying bit transfer mode. Current pattern is exclusive OR'ed into destination.

PAUSE ---

Multitasking stub for source compatability with future products.

PEN.NORMAL --

Resets the state of the pen in the current graphport:

```
  pensize  = 1,1
  penmode  = patcopy
  penpat   = black
```

PENMODE n --

Sets pen transfer mode. Allowable modes include:

```
   PATCOPY     PATXOR     PATOR     PATBIC
   NOTPATCOPY  NOTPATXOR  NOTPATOR  NOTPATBIC
```

See individual modes for definition of function.

PENPAT addr --

Sets the pen pattern for current window.

PENSIZE width\height --

Sets pen size to width and height scaled by XYSCALE.

PFA token -- pfa

Convert the token of a compiled definition to its pfa. "p-f-a"

PICK n1 -- n2

Return the stack item n1 items from the top (not including n1). For example, 2 PICK is functionally equivalent to OVER ; 1 PICK is functionally equivalent to DUP . An error condition exists for n1 less than 1, system response is to leave n1 on the stack.

PLAIN -- n

Constant for no text enhancements.

PLAY addr --

Passes addr+2 to the Macintosh sound generator. Addr contains 16-bit length of the waveform description record at addr+2 on. System will wait until the sound is completed.

PLOT.ICON rect\handle --

Plots icon at handle within supplied rectangle.

PNTR -- addr

User variable containing the address to which characters are transferred. "p-n-t-r"

POCKET -- addr

User area array used for parsing text strings from the input stream. WORD uses this 256 byte area when extracting strings from the input stream.

POINT position mode\position\file# --

Positions the file pointer to the specified location in the specified file (it "points" into the file).

POINT>XY point -- x\y

Unpacks point into x under y.

POLYGON handle --

Refer to Level 2 advanced graphics documentation.

POSITION.FIXED rec#\file# -- rec len\file#

Primitive used for fixed length record file access. Positions the file pointer at the start of the specified record in the specified file.

POST.EVENT event.code\event.msg --

Places event of type event.code into event queue with message of event.msg. BE CAREFUL not to post events for such things as activate or update events as these are sure to crash the system. Normally posted events should be limited to user designated range 12-15.

PREV -- addr

Variable which points to the disc buffer most recently referenced. The UPDATE command marks this buffer as changed so it is later written to disc when needed.

PRINT addr\cnt --

Sends the string of characters starting addr for cnt bytes to the printer.

PRINT.BITS t\l\b\r\bit map --

Prints the pixels within the top, left, bottom, right rectangle of bitmap to an Apple Imagewriter printer. bitmap is wptr+2.

PRINT.FCB -- addr

Returns the address of the printer device driver FCB.

PRINT.SCREEN ---

Transmits the contents of the screen to the Apple Imagewriter printer.

PRINT.WINDOW ---

Transmits the contents of the currently active window to the Apple Imagewriter printer.

PRINTER -- addr

Returns address of printer resource variable. Used to turn on and off duplicating screen output to the printer. PRINTER ON turns on printer PRINTER OFF turns off printer.

PRINTER.ONLY -- addr

Returns the address of the device console table which directs output to the printer only.

PTINRECT point\rect addr -- flag

Returns a true flag if point is within the specified rectangle.

PURGABLE handle --

Marks the specified handle as purgable by the memory manager.

PURGE.MENUBAR addr --

Removes all menu entries between addr and HERE from the menu list.

PURGE.WINDOWS addr --

Closes and deletes all windows between addr and HERE.

PUSH.BUTTON n1\n2\n3\n4\n5 --

Refer to Level 2 controls documentation.

PUT.SCRAP addr\cnt\res type -- io result

Writes cnt bytes from addr to the desk scrap and marks it with res type.

QUERY ---

Accepts input of up to 80 characters from the keyboard. A carriage return will stop input when encountered. The string is stored in the terminal input buffer. Two nulls are appended to the input stream and CNT contains the actual number of characters input. A space is output when a CR is entered. WORD may be used to accept text from this buffer as the input stream by setting >IN and BLK to zero. See TIB , WORD , >IN , and BLK .

QUIET -- addr

User variable mode switch. When non zero, indicates the buzzer is not to sound when a user-defined error condition is encountered (ie. using ERROR"). QUIET ON enables quiet mode. QUIET OFF disables quiet mode.

QUIT ---

Stops execution of the current task, clears the return stack and returns control to the terminal. The data stack is preserved.

R/W addr\block\flag --

Mass storage read/write primitive. Addr specifies the source or destination block buffer, block is the number of the referenced block, and flag determines the operation to take place (0 implies write, 1 implies read). Execution is vectored through the user variable (R/W) to the user specified read/write handler.

R0 -- addr

User variable containing the initial location of the return stack.
See RP! "r-zero"

R> -- n

Pops the top item off of the return stack and pushes it onto the data stack. MUST be matched with a >R within the same colon definition or an unpredictable error will occur. See >R
"r-from"

R>DROP ---

Code routine which drops the top item from the return stack.
"r-from-drop"

R@ -- n

Copies the top of the return stack to the data stack. Should only be used between a >R ... R> sequence. "r-fetch"

RANDOM -- n

Returns a psuedo random number between 0 and 32767. See SEED

RANGE n\min\max -- n\bool

Performs a range check for min <= n <= max. Bool is the boolean result (true if min <= n <= max).

RADIO.BUTTON n1\n2\n3\n4\n5 --

Refer to MacFORTH Level 2 controls documentation.

RANGE.OF n1\min\max -- [n1] or []

Marks the beginning of a conditional branch within a case statement. Used in the form:

```
  CASE ...
    <min> <max> RANGE.OF ... ENDOF
  ENDCASE
```

If n1 is <= max and >= min, all arguments are DROPped and execution continues through ENDOF and then skips past the next ENDCASE . If n1 is not with min and max, min and max are DROPped and execution continues after ENDOF . See OF , ENDOF , CASE , and ENDCASE .

RDRAW dx\dy --

Relative draw. Draws from current XY position to XY position at x + dx, y + dy dots to the right of and below the pen are modified according to the pen size, shape, pattern and mode.

READ.FIXED addr\rec#\file# --

Reads the fixed length record rec# from the specified file to addr.

READ.TEXT addr\cnt\file# --

Reads the data record from the specified file at the current file position to addr, for a maximum of cnt bytes. If the record is larger than cnt bytes, the pointer in the file is left pointing at the last byte transferred. The next read (without adjusting the pointer), will begin with the rest of the record.

READ.VIRTUAL addr\cnt\file addr\file# --

Reads data from the specified file to addr for a maximum of cnt bytes starting at the file addr given.

REAL.FONT? font#\size -- flag

Returns true if font is an actual rather than synthesized font.

RECOVER --

Unconditionally recovers at the most recently specified recovery stack frame. Refer to the Advanced Topics chapter for more information.

RECOVER.HANDLE ptr -- handle

Returns handle for address if address corresponds with a valid relocatable data structure in the heap. Reference APPDEVDOC: RecoverHandle

RECT t\l\b\r --

Creates rectangle data structure which will place it's address on the stack when executed (like variable). Used in the form:

<top> <left> <bottom> <right> RECT <rect name>

To create a rectangle data structure called <rect name>.

RECTANGLE x1\y1\x2\y2\[pattern addr]\mode --

Draws a rectangle.

REG.SET -- addr

Returns the address of a register snapshot array. Contains a snapshot of the 68000 registers and the last 16 bytes of the parameter and return stacks when the last exception occurred. See (EXCPT) .

REGION ---

Refer to Level 2 advanced graphics documentation.

RELEASE addr --

Multitasking stub for source compatibility with future products.

REMOVE file# --

Removes the specified file from the list of file control blocks.

RENAME new file$\file# --

Renames the specified file with the new name.

REPEAT ---

Terminates a finite control structure. Used within a colon definition in the form:

BEGIN . . . WHILE . . . REPEAT

Returns control to the word following the corresponding BEGIN . The error message "CONDITIONALS NOT PAIRED" indicates the structure is missing either a BEGIN or WHILE command.

RESIZE.HANDLE handle\size -- flag

Attempts to resize the specified handle in the heap. Returns non-zero if unsuccessful. Reference APDEVDOC: realloc.handle

RESIZE.OBJECT size --

Attempts to resize the current object space. An error message results if insufficient heap space exists or if the requested size is unable to contain the current object image. Use the ROOM function to determine the current object space allocation. See MINIMUM.OBJECT ROOM

RESIZE.VOCAB size --

Attempts to resize the current vocabulary to the requested size. An error message is generated if insufficient heap space is available or if the vocabulary is currently larger than the requested size.
See MINIMUM.VOCAB ROOM

RESUME ---

Terminates a user specified error handler. See ON.ERROR

RETRY -- addr

User variable pointing to the most recently specified error recovery frame. See ABORT" , RECOVER , ON.ABORT .

REWIND file# --

"Rewinds" the specified file's pointer to the beginning of the file.

RMOVE dx\dy --

Relative move. Moves the current pen position to current position plus the supplied offset.

ROLL n1 -- n2

Extracts the stack item n1 from the top (not including n1). The remaining stack items are moved into the vacated position. For example, 3 ROLL is equivalent to ROT 2 ROLL is equivalent to SWAP. Error if n1 is less than or equal to one with no action taken.

ROOM ---

Displays the amount of remaining memory available for use. The message displayed is

```
xxxxxxxx  Object Bytes Available
yyyyyyyy  Current Vocabulary Bytes Available
zzzzzzzz  Heap Bytes Available
```

Where xxxxxxxx represents current object area (pointed to by OBJECT.HANDLE), yyyyyyyy represents the amount of space in the CURRENT vocabulary (pointed to by CURRENT) and zzzzzzzz represents the total amount of space remaining in the HEAP.

ROT n1\n2\n3 -- n2\n3\n1

Rotates the top three stack items. The third item is brought to the top. "rote"

RP! ---

Initializes the return stack to point to the value contained in the user variable R0 . "r-p-store"

RP@ -- addr

Returns the address of the top of the return stack.

RRECTANGLE x1\y1\x2\y2\ch\cw\[pattern]\mode --

Draws a rounded rectangle with ch by ch radius rounding.

RSRVMEM size -- io result

Requests the memory manager to reserve size bytes in the heap for an upcoming, relatively static or locked data structure. See Apple's Developer's documentation for further details. Reference: ResrvMem

RST.PRINTER ---

Resets the Apple Imagewriter printer by sending an esc c sequence.

S0 -- addr

User Variable containing the address of the top of the stack when it is empty. "s-zero"

SAVE-BUFFERS ---

Writes all UPDATEd blocks to disc. The contents of the block buffers remain unchanged and available. See BLOCK , UPDATE , and FLUSH .

SCALE n1\n2 -- n3

Arithmetically shifts n1 according to the value of n2. If n2 is negative, n1 is shifted right, if n2 is positive, n1 is shifted left. The absolute value of n2 determines the actual shift. For example:

```
    : NEW.2*  ( n -- n*2 )   1 SCALE  ;
```

is equivalent to 2* . Error if n2 is greater than 31; system responds by leaving n3 as zero.

SCALE>XY x\y -- x'\y'

Scales the x and y coordinates given as follows:

```
    x' = x 100 *   x-scale  /
    y' = y 100 *   y-scale  /
```

SCALE>Y n -- n * 100\y scale

Scales n to y-axis coordinates.

SCAN.FROM -- addr

Computes the address within the input stream of the next word. addr is either TIB + >IN or BLK + >IN if BLK is non- zero. See BLK , TIB , and >IN .

SCR -- addr

User variable containing the number of the block (or "screen") most recently LISTed or EDITed. "s-c-r"

SCRAP.COUNTER -- n

Returns the number of times the desk scrap has been zeroed.

SCRAP.HANDLE -- addr

Returns the address containing the desk scrap handle.

SCRAP.LEN -- addr

Returns the address containing the 16-bit length of the desk scrap.

SCRATCH -- addr

User variable used to hold the most recently referenced option bit switch. All switch references set the appropriate bit at this location.

SCREEN.BITS -- addr

Returns the address of the entire screen bitmap.

SCREEN.BOUNDS -- addr

Returns the address of the rectangle which contains the maximum screen coordinates.

SCROLL scroll rect\dh\dv\update handle --

Refer to MacFORTH Level 2 Advanced Graphics documentation for more information.

SCROLL.LEFT/RIGHT -- n

Constant bit mask for the horizontal scroll bar window attribute.

SCROLL.UP ---

Scrolls the current window up the number of pixels contained in the current line height of the window. See GET.LINE.HEIGHT LINE.HEIGHT

SCROLL.UP/DOWN -- n

Constant bit mask for the vertical scroll bar window attribute.

SEED -- addr

Returns the address of the random number generator seed. The previous seed is saved at SEED +2.

SELECT file# --

Selects the specified file as the current blocks file.

SELECT.WINDOW wptr --

Selects the specified window as the currently active window.

SEND.BEHIND wptr\behind wptr --

Re-links the window specified by wptr behind the window specified by behind wptr.

SET.CONTROL n1\n2 --

Refer to MacFORTH Level 2 Controls documentation.

SET.CONTROL.MAX n1\n2 --

Refer to MacFORTH Level 2 Controls documentation.

SET.CONTROL.MIN n1\n2 --

Refer to MacFORTH Level 2 Controls documentation.

SET.CONTROL.RANGE n1\n2\n3 --

Refer to MacFORTH Level 2 Controls documentation.

SET.CURSOR cursor address --

Sets cursor to supplied address (0 indicates default NW arrow).
See INIT.CURSOR CURSOR

SET.EOF #bytes\file# --

Sets the size of the specified file to #bytes.

SET.FENCE --

Sets the FENCE to point to the current dictionary offset within the relocatable vocabulary structure. FENCE is stored at CURRENT @@ 8+ .
The current vocabulary offset pointer is stored at CURRENT @@

SET.FILE.INFO file# --

Writes the information from the specified file's fcb to disc.

**SET.ITEM$** item\new item$\menu id --

Replaces the current menu item string with supplied string.

SET.ORIGIN X\Y --

Establishes window origin in QuickDraw screen coordinates.

SET.REC.LEN rec len\file# --

Sets the fixed record length for the specified fixed file.

SET.STRING handle\$ addr --

Places string into handle. Prior handle contents are lost.
See NEW.STRING

SET.WTITLE $ addr\wptr --

Sets the window title to supplied string. If the window is visible, its title will be updated immediately.

SETUP.SERIAL # stop bits\parity\# data bits\baud rate\FCB addr --

Sets up the serial interface. Refer to the Printer/Serial Interface chapter.

SHADOW -- 16

Constant bit mask for shadow text attribute.

SHOW starting block#\ending block# --

Generate a listing of TRIADs between the starting and ending block numbers given. See TRIAD .

SHOW.CONTROLS wptr --

Displays controls for window. Refer to MacFORTH Level 2 Controls documentation.

SHOW.CURSOR --

Decrements the cursor level. When the cursor level is 0, the cursor is visible. Use INIT.CURSOR to reset cursor level to 0. See HIDE.CURSOR

SHOW.PEN --

Increments the pen level in the current window. When the pen level is 0, drawing functions are displayed on the screen. This is used when defining regions, or pictures where the pen is used to depict a region or picture without actually drawing the outline on the screen.
See HIDE.PEN

SHOW.WINDOW wptr --

Sets the visible flag in the specified window. Visible portions of the window will appear on the display immediately.

SIGN n --

Insert the ASCII negative sign into the pictured numeric output string if n is negative. *** Note: You must retain the sign of the original value being converted and place it on the stack before executing SIGN . Error if used outside of <# and #> pair with no system response. See <# and #> .

SIN angle -- sine * 10000

Returns integer sine of angle * 10000. (4 digit precision).

SIZE.BOX -- n

Constant bit mask for size.box window attribute.

SIZE.WINDOW wptr --

Recalculates the specified window's content region, allocating space for only desired scroll bars.

SMUDGE ---

Used during word definition to toggle the "smudge bit" in a definition's name field. This prevents the incomplete definition from being found during dictionary searches, until compilation is completed without error.

SOUND.FCB -- addr

Returns the address of the sound driver FCB.

SP! ---

Procedure to initialize the stack pointer to S0 . See S0 . "s-p-store"

SP@ -- addr

Returns the address of the top of the stack just before SP@ was executed. "s-p-fetch"

SPACE ---

Outputs an ASCII space.

SPACES n --

Outputs n spaces. No action is taken for n less than one.

SQRT (n -- square root)

Computes a 16-bit square root from 32-bit square n.

SRCBIC -- 3

QuickDraw bit transfer mode. Bits set in the source pattern are cleared in the destination.

SRCCOPY -- 4

QuickDraw pattern transfer mode. All bits set in the source pattern are copied to the destination.

SRCOR -- 4

QuickDraw pattern transfer mode. Bits set in the source pattern are set in the destination.

SRCXOR -- 3

QuickDraw bit transfer mode. Bits set in the source pattern are inverted in the destination.

STACK.ERROR (flag --)

Aborts with " Not Enough Stack Items" error message if flag is true.

START.FLAG -- n

Constant used by MacFORTH to determine if the system has been booted.

STATE -- addr

User variable containing the compilation state. A non-zero value indicates compilation mode, zero indicates execution.

STATUS -- addr

Returns the base address of the user area.

STILL.DOWN -- flag

Returns true while the mouse is still down. If the mouse comes up and goes down between samples, returns false.

STRINGWIDTH addr -- n

Returns the width, in pixels of the string at addr.

SWAP n1\n2 -- n2\n1

Swaps the top two stack items.

SYS.FILE -- addr

FCB address used for system related file functions.

SYS.WINDOW -- wptr

Default interactive MacFORTH Window.

SYSBEEP duration --

Sounds the buzzer for the number of specified 1/60 sec ticks.

SYSPARMS -- addr

Returns the low memory address of data copied from battery backed-up memory.

SYSTEM.EDIT n -- flag

Allows the desk manager to respond to editing functions pressed while a desk accessory is active. If flag is true, the event was handled by the desk manager, and no user action is required. Refer to the supplied Macforth editor source code for examples.

TAB.STOPS -- addr

Variable containing the number of spaces between tab stops.

TEACTIVATE

Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TECALTEXT

Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TECLICK

Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TECOPY

Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TECUT

Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TEDEACTIVATE

Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TEDELETE

Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TEDISPOSE
Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TEIDLE
Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TEINSERT
Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TEKEY
Refer to MacFORTH MacFORTH Level 2 TE interface documentation.

TENEW
Refer to MacFORTH Level 2 TE interface documentation.

TEPASTE
Refer to MacFORTH Level 2 TE interface documentation.

TERECORD
Refer to MacFORTH Level 2 TE interface documentation.

TESCROLL
Refer to MacFORTH Level 2 TE interface documentation.

TESET.JUST
Refer to MacFORTH Level 2 TE interface documentation.

TESET.SELECT
Refer to MacFORTH Level 2 TE interface documentation.

TESET.TEXT
Refer to MacFORTH Level 2 TE interface documentation.

TEST.CONTROL
Refer to MacFORTH Level 2 TE interface documentation.

TEUPDATE
Refer to MacFORTH Level 2 TE interface documentation.

TEXT.BOX
Refer to MacFORTH Level 2 TE interface documentation.

TEXT.CLICK

Refer to MacFORTH Level 2 TE interface documentation.

TEXT.FIELD

Refer to MacFORTH Level 2 TE interface documentation.

TEXT.RECORD -- n

Constant bit mask for window attribute which indicates that a text record is pointed to by the refcon field of the window. Refer to MacFORTH Level 2 TE documentation.

TEXTFONT n --

Selects the current text font. Font 0 is reserved for the system, font 1 is the default for user applications. MacFORTH uses font 4 (fixed space Monaco).

TEXTMODE text mode --

Sets the current text bit transfer mode. Valid modes include:

```
SRCCOPY      SRCOR      SRCXOR      SRCBIC
NOTSRCCOPY   NOTSRCOR   NOTSRCXOR   NOTSRCBIC
```

TEXTSIZE size --

Sets the text size for current window. MacFORTH windows maintain LINE.HEIGHT for scrolling and general text output. If you set textsize greater than LINE.HEIGHT you will overwrite data on the prior line.

TEXTSTYLE n --

Selects the text style. Each of the first 7 bits enable a particular text enhancement:

Bit*	Hex Value	Text Mode (MacFORTH Constant)
0	1	BOLD
1	2	ITALIC
2	4	UNDERLINE
3	8	OUTLINE
4	16	SHADOW
5	32	CONDENSED
6	64	EXTENDED

THEN ---

Marks the end of a conditional structure. Used within a colon definition in the form:

IF ... ELSE ... THEN or IF ... THEN

The word following THEN is executed after the code for IF or ELSE (if present). The error message "CONDITIONALS NOT PAIRED" indicates there was no preceding IF .

THIS.CONTROL -- addr

Refer to MacFORTH Level 2 Controls documentation.

THIS.PART -- addr

Refer to MacFORTH Level 2 Controls documentation.

THRU starting block#\ending block# --

Loads screens between and including the starting and ending block numbers given.

TIB -- addr

User variable containing the address of the terminal input buffer.

TICKCOUNT -- tick count

Returns real time clock ticks (in 60<u>ths</u> of a second).

TO.HEAP handle --

Returns the specified handle to the heap manager.

TOGGLE addr\mask --

Complements the 8-bit value in addr by the bit mask given.

TOGGLE.CONTROL -- n

Refer to MacFORTH Level 2 Controls documentation.

TOKEN.FOR -- token

Inputs the next word in the input stream and converts it to a token. If no token is found, 0 is returned instead.

TOKEN>ADDR token -- addr

Converts a relocatable token to a physical address.

TONE duration\volume\frequency * 10 --

Outputs a tone via the sound generator. duration (0-255) is 1/60ths of a second, volume (0-255) is a relative volume, and frequecy is hertz*10.

TRACE -- addr

Compiler Mode switch. When enabled, the compiler emplaces the token (TRACE) into the dictionary prior to every token that would otherwise normally be compiled. At run-time, (TRACE) tests the state of DEBUG, and if true, displays the stack contents with .S and the name of the following token. (See (TRACE), DEBUG, and ?TRACE)
TRACE ON enables trace mode. TRACE OFF disables trace mode.

TRACE.TOKEN -- addr

Returns the address of the variable containing the token to be compiled when the trace switch is on. See TRACE

TRACK.CONTROL n1\n2 -- flag

Refer to MacFORTH Level 2 Controls documentation.

TRIAD block# --

Displays the triad containing block#. The three blocks include block#, beginning with a block number evenly divided by three. Output is suitable for source text records and can be used to replace only updated blocks in the master listing.

TRUE -- -1

Constant for boolean true value.

TRUNK -- addr

User variable containing the task unique address of the task's FORTH vocabulary.

TRY ---

Pushes the recovery stack frame into the return stack. See RECOVER , ABORT" .

TYPE addr\cnt --

Outputs a string. Transmits cnt characters beginning at addr to the current output device. No action is taken for cnt less than 1.

UNDERLINE -- 04

Constant bit mask for underline text attribute.

UNIQUE.MSG -- addr

User Variable containing flag which when true, causes CREATE to issue the warning message "ISN'T UNIQUE" when a newly created word name field is not unique within CONTEXT and TRUNK .

UNLOAD.SCRAP -- io result

Writes the desk scrap to disc under the file name "CLIPBOARD".

UNLOCK.FILE file* --

Unlocks the specifield file.

UNLOCK.HANDLE handle --

Marks the specified handle as unlocked. See Apple Developer's documentation for further details. Reference: HUnlock

UNTIL flag --

Terminates a finite control structure. Within a colon definition, marks the end of a BEGIN ... UNTIL loop which will terminate based on the value of flag. If flag is true, the loop is terminated and control is passed to the word following UNTIL . If flag is false, the loop continues and control is passed back to the word following BEGIN . BEGIN ... UNTIL loops may be nested freely as long as each BEGIN is paired with an UNTIL or WHILE...REPEAT . The error message "CONDITIONALS NOT PAIRED !" may indicate an UNTIL is not paired with a BEGIN . See BEGIN , WHILE , and REPEAT .

UP.BUTTON -- n

Refer to MacFORTH MacFORTH Level 2 Controls documentation.

UPDATE ---

Mark the most recently referenced block buffer as modified. The block will subsequently be written to mass storage when its buffer is needed for storage of a different block, or when SAVE-BUFFERS or FLUSH is executed.

UPDATE.EVENT -- n

Constant event code returned by DO.EVENTS on a update event.

UPPER addr\cnt --

Converts lowercase characters to uppercase. Any lowercase ASCII alpha characters in the string at addr for cnt bytes are converted to uppercase ASCII alpha characters.

UPPER.LEFT (--)

Sets the graphics XYOFFSET to the upper left corner of the current window.

USE -- addr

Variable containing the address of the block buffer to use next. This is the least recently written block buffer.

USE" ---

Used in the following format:

USE" <blocks file name>"

to assign, open and select the specified blocks file.

USER n --

User variable defining word. Used in the form:

n USER <name>

to create a user variable named <name>. n is the cell offset within the user area where the value of <name> is stored. Execution of <name> leaves its absolute user area storage address.

VARIABLE ---

Defining word to create variable definitions. Used in the form:

VARIABLE <name>

to create a dictionary entry for <name> and allot four bytes for storage in the parameter field. When <name> is later executed, it will place the pfa of <name> on the stack.

VBAR.BOUNDS wptr -- t\l\b\r

Refer to MacFORTH Level 2 Controls documentation.

VECTOR (x1\y1\x2\y2 --)

Draws a line from (x1,y1) to (x2,y2).

VERSION ---

Types the current software version number and CSI copyright notice. Used in TRIAD and COLD .

VERSION# -- n

Constant containing the specific version of the software release.

VIRTUAL -- position mode

Constant for the virtual file positioning mode. See POINT

VOCABULARY size --

A defining word to create a new vocabulary. Used in the form:

<size> VOCABULARY <name>

to create (in the CURRENT vocabulary) a dictionary entry for <name>, which specifies a new ordered list of word definitions. Subsequent execution of <name> will make it the CONTEXT vocabulary. When <name> becomes the CURRENT vocabulary (see DEFINITIONS), new definitions will be created in that list (vocabulary). size represents the desired initial size of the vocabulary.

W! w\addr --

Stores the 16-bit value w at addr. The error message "Address Error Trap at addr" indicates addr is odd. See >W!<
"w-store"

W* w1\w2 -- n3

Returns the signed 32-bit product of the signed 16-bit numbers w1 and w2. "w times"

W, w --

Emplaces w into the dictionary. Stores the 16-bit value in the dictionary at the current dictionary pointer value and increments the dictionary pointer by 2.

W.ATTRIBUTES attributes\wptr --

Sets window attributes before window is displayed. Valid attributes include:

CLOSE.BOX	NOT.VISIBLE	SIZE.BOX
SCROLL.UP/DOWN	SCROLL.LEFT/RIGHT	TEXT.RECORD

W.BEHIND front wptr\back wptr --

Sets window order before window is displayed. The back wptr will be placed behind front wptr when the window is added to the window list.

W.BOUNDS t\l\b\r\wptr --

Determines the position and size of a window before it is added to the window list and displayed.

W.LINKAGE -- addr

Variable containg the latest pointer to a linked list of windows in chronological order. This list is traversed during FORGET to close any window which is about to be forgotten.

W.TITLE $addr\wptr --

Sets title for window before window is displayed.

W.TYPE w.type\wptr --

Sets window type for window before it is displayed.

W/ n1\n2 -- quotient

Divides 32-bit n1 by 16-bit n2 leaving a 16-bit quotient. This routine uses the 68000 signed divide hardware instruction for speed. "w-divide"

W/MOD n1\n2 -- remainder\quotient

Divides the 32-bit signed number n1 by the 16-bit signed number n2, leaving the 16-bit remainder and quotient. This routine directly utilizes the 68000 signed divide hardware instruction. "w-divide-mod"

W>FUNC>L n --

Defining word for creating Macintosh function calls. Refer to the Advanced Topics chapter.

W>MT n --

Defining word for creating Macintosh function calls. Refer to the Advanced Topics chapter.

W@ addr -- w

Return the 16-bit value at addr. The error message "Address Error Trap at addr" indicates addr is odd. See >W@< "w-fetch"

WAIT n --

Stub used to maintian source compatability with later products.

WAIT.MOUSE.UP -- flag

Waits for mouse button to come up. Returns false if button is already up.

WATCH -- addr

Returns the address of the watch cursor array.

WCONSTANT n --

16-bit constant defining word. When later executed, pushes signed 16-bit value on the stack.

WHILE flag --

Marks the beginning of the "true portion" of a finite loop construct. Used in a colon definition in the form:

BEGIN ... WHILE ... REPEAT

On a true flag, continue execution through to REPEAT , which then returns control back to the word following the BEGIN . On a false flag, skip to the word following the REPEAT , exiting the control structure. The error message CONDITIONALS NOT PAIRED indicates the WHILE was not nested within a BEGIN .. REPEAT control structure within the current definition.

WHITE -- addr

Returns the address of the white pattern.

WINDOW wptr --

Directs output to the specified window.

WLIT -- n

Pushes the next 16 bit value in the interpretation stream into the stack and advances the interpreter pointer over it.

WMOD n\w -- remainder

Divides 32-bit n by 16-bit w leaving the 16-bit remainder of the division. This routine uses the 68000 signed divide hardware instruction for speed. "w-mod"

WORD char -- addr

Parses a string from the input stream. Parse characters from the input stream until the non-zero delimiting character (char) is encountered, or the input stream is exhausted, ignoring leading delimiters. The characters are stored as a packed string with the character count in the first position. The actual delimiter encountered (char or null) is stored at the end of the text string, but not included in the count.

If the input stream was exhausted as WORD was executed, a zero length string will result. The address left on the stack points to the beginning of the string (the count byte), the text is placed within the user area at POCKET . An error condition exists if the string length exceeds 255, leaving only the last 255 characters available. An unchecked error occurs if the char given is 0.

WORDS ---

List the CONTEXT vocabulary starting with the most recent definition. (Some old-time FORTH programmers may call this function "VLIST".)

WRITE.FIXED addr\rec#\file# --

Writes the data at addr to the fixed record rec# in the specified file.

WRITE.TEXT addr\cnt\file# --

Writes the data at addr for cnt bytes (remember to append a carriage return to text records) into the specified file at the current file pointer location.

WRITE.VIRTUAL addr\cnt\file addr\file# --

Writes the data at addre for cnt bytes into the specified file starting at the file addr given.

XEXPECT addr\cnt --

Primitive Mac console string input operator (see EXPECT). Flashes the cursor, allows Backspaces to edit the input string and terminates on Return, setting CNT to the actual number of characters received.

XLATE x\y -- x'\y'

Rotates, scales and translates the point (x,y) according to the current window XYPIVOT (angle), XYSCALE , and XYOFFSET . If the cartesian flag is true, the Y coordinate is negated. (x',y') are expressed in QuickDraw coordinates relative to the current window.

XOR n1\n2 -- n3

Leave the bitwise exclusive-or of n1 and n2. "x-or"

XY><TLBR x1\y1\x2\y2 -- top\left\bottom\right

<< or >>

top\left\bottom\right -- x1\y1\x2\y2

Converts two xy point pairs to tlbr form, or vice-versa.

XY>POINT x\y -- point

Packs x under y into 32 bit point. Y resides in high order word, x in low order.

XYAXIS ---

Displays a 100 x 100 cross hair at the current screen origin. Positive x and y are marked with '+', negative with '-'.

XYOFFSET x\y --

Sets the offset to the center of the coordinate system to x dots from the right and y dots from the top of the current window.

XYPIVOT angle --

Causes all subsequent line and dot coordinates within the current window to be pivoted to angle degrees. Shapes are not pivoted.

XYSCALE x scale\y scale --

Causes all points in the current window to be scaled by the specified x and y scale. Full scale is 100 100.

ZERO.SCRAP -- io result

Zeroes the desk scrap and increments SCRAP.COUNTER .

[---

Begin execution mode. The text from the input stream is subsequently executed. See] . "left-bracket"

[COMPILE] ---

Forces compilation of an immediate word. Used in a colon- definition in the form:

```
  [COMPILE] <name>
```

where <name> is an immediate word. This allows compilation of a compiling word when it would otherwise be executed. "bracket-compile-bracket"

] ---

Begin compilation mode. The text from the input stream is subsequently compiled. See ["right bracket"

{ ---

Accepts and ignores comments from the input stream until the next delimiting right brace. Very similar in usage to (, but can be used when multiple occurrances of parentheses are desired in a comment. For example:

```
  { xxx ( xxx ) xxxx ( xxx ) xxxx }
```

is a valid comment. "brace"

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ASCII CODE CHART

				MSD (HEX)	0	1	2	3	4	5	6	7
LSD (HEX)	BITS			B1 B2 B3	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	B4	B5	B6	B7	CONTROL							
0	0	0	0	0	NUL 0 (0)	DLE 10 (16)	SP 20 (32)	0 30 (48)	@ 40 (64)	P 50 (80)	` 60 (96)	p 70 (112)
1	0	0	0	1	SOH 1 (1)	DC1 11 (17)	! 21 (33)	1 31 (49)	A 41 (65)	Q 51 (81)	a 61 (97)	q 71 (113)
2	0	0	1	0	STX 2 (2)	DC2 12 (18)	" 22 (34)	2 32 (50)	B 42 (66)	R 52 (82)	b 62 (98)	r 72 (114)
3	0	0	1	1	ETX 3 (3)	DC3 13 (19)	# 23 (35)	3 33 (51)	C 43 (67)	S 53 (83)	c 63 (99)	s 73 (115)
4	0	1	0	0	EOT 4 (4)	DC4 14 (20)	$ 24 (36)	4 34 (52)	D 44 (68)	T 54 (84)	d 64 (100)	t 74 (116)
5	0	1	0	1	ENQ 5 (5)	NAK 15 (21)	% 25 (37)	5 35 (53)	E 45 (69)	U 55 (85)	e 65 (101)	u 75 (117)
6	0	1	1	0	ACK 6 (6)	SYN 16 (22)	& 26 (38)	6 36 (54)	F 46 (70)	V 56 (86)	f 66 (102)	v 76 (118)
7	0	1	1	1	BEL 7 (7)	ETB 17 (23)	' 27 (39)	7 37 (55)	G 47 (71)	W 57 (87)	g 67 (103)	w 77 (119)
8	1	0	0	0	BS 8 (8)	CAN 18 (24)	(28 (40)	8 38 (56)	H 48 (72)	X 58 (88)	h 68 (104)	x 78 (120)
9	1	0	0	1	HT 9 (9)	EM 19 (25)	) 29 (41)	9 39 (57)	I 49 (73)	Y 59 (89)	i 69 (105)	y 79 (121)
A	1	0	1	0	LF A (10)	SUB 1A (26)	* 2A (42)	: 3A (58)	J 4A (74)	Z 5A (90)	j 6A (106)	z 7A (122)
B	1	0	1	1	VT B (11)	ESC 1B (27)	+ 2B (43)	; 3B (59)	K 4B (75)	[5B (91)	k 6B (107)	{ 7B (123)
C	1	1	0	0	FF C (12)	FS 1C (28)	, 2C (44)	< 3C (60)	L 4C (76)	\ 5C (92)	l 6C (108)	¦ 7C (124)
D	1	1	0	1	CR D (13)	GS 1D (29)	– 2D (45)	= 3D (61)	M 4D (77)	] 5D (93)	m 6D (109)	} 7D (125)
E	1	1	1	0	SO E (14)	RS 1E (30)	. 2E (46)	> 3E (62)	N 4E (78)	∧ 5E (94)	n 6E (110)	~ 7E (126)
F	1	1	1	1	SI F (15)	US 1F (31)	/ 2F (47)	? 3F (63)	O 4F (79)	— 5F (95)	o 6F (111)	RUBOUT (DEL) 7F (127)

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