

# **RamWorks II**

## **User's Manual**

**APPLIED ENGINEERING**

*Downloaded from [www.Apple2Online.com](http://www.Apple2Online.com)*





# RamWorks II

## User's Manual

v2.0

---

Applied Engineering warrants the RamWorks II, RamWorks Memory Expander cards, and memory chips installed by or purchased from Applied Engineering against defects in material and workmanship for a period of 5 years from the date of original retail purchase. If you discover a defect, Applied Engineering will, at its option, repair, replace, or refund the purchase price of the product, provided you return the product during the warranty period, transportation prepaid, to Applied Engineering. Prior to returning the product for warranty consideration, call Applied Engineering Technical Support for a return material authorization (RMA) number and shipping instructions.

---

This manual and the software (computer programs) described herein are copyrighted by Applied Engineering with all rights reserved. Under the copyright laws, this manual or the programs may not be copied, in whole or in part, without the written consent of Applied Engineering, except in the normal use of the software or to make an archival copy. This exception does not allow copies to be made for others, whether or not sold, but all of the materials purchased (with all archive copies) may be sold, loaned, or given to another person. Under the law, copying includes translating into another language or format.

You may use this software on any computer owned by you but extra copies cannot be made for this purpose.

---

Applied Engineering cannot guarantee that you will receive notice of revisions to the software or products described in this manual. Be sure to check with your dealer or Applied Engineering for information on possible updates.

---

Apple® is a registered trademark of Apple Computer, Inc.  
AppleWorks™, DOS 3.3™, and ProDOS™ are trademarks of Apple Computer, Inc.  
Applied Engineering®, RamWorks®, and RamWorks II®, are registered trademarks of Applied Engineering.  
TimeMaster II™, ProDrive™, RamDrive™, and Super AppleWorks Desktop Expander™ are trademarks of Applied Engineering.

---

Applied Engineering  
P.O. Box 798  
Carrollton, Texas 75006

Sales: (214) 241-6060 9 AM - 11 PM 7 days  
Technical Support: (214) 241-6069 9 AM - 5 PM Monday - Friday

<b>Preface</b>	<b>iii</b>
About This Manual... iii	
Applied Engineering Technical Support iv	

---

1

<b>Introduction</b>	<b>1</b>
About RamWorks II 1	
System Requirements 1	
For More Information 2	

---

2

<b>RamWorks II Installation</b>	<b>3</b>
Before You Begin... 3	
Installing RamWorks II 4	

---

3

<b>AppleWorks and RamWorks II</b>	<b>5</b>
Making Great Greater! 5	
Using The Super AppleWorks Desktop Expander Utility 5	
About the New Features 6	

---

4

<b>Using RamWorks II</b>	<b>9</b>
RamWorks II and Application Software 9	
Activating RamWorks II with Pascal or CP/M 9	
Activating RamWorks II using Applesoft BASIC 9	
Escape Mode Features 10	
Upper Case Restrict Feature 11	
Display Features with RamWorks II 11	
Controlling RamWorks II Display from Applesoft BASIC 12	

---

## Contents

---

5

---

<b>RamWorks II RamDrive</b>	<b>13</b>
Introduction to RamDrive	13
RamDrive for DOS 3.3	14
RAMCOPY Instructions	20
SPEEDOS Documentation	20
ProDrive for ProDOS	21
Using the PARTITION Program	23
Instructions for COPY.FILES	24

6

---

<b>RamWorks II Memory Configuration</b>	<b>25</b>
Introduction	25
The Proper Memory Chips	25
Memory Chip Installation	25
Installing the Memory Expander Card on RamWorks II	28
Memory Bank Configurations	30

7

---

<b>RamWorks II Auxillary Memory</b>	<b>31</b>
For Programmers Only...	31
Bank Switching	31
Programming Suggestions	32

A

---

<b>Early "Revision A" Apple //e Computers</b>	<b>35</b>
---	-----------

B

---

<b>RamWorks II Memory Test</b>	<b>36</b>
--------------------------------	-----------

C

---

<b>RGB Color Option for RamWorks II</b>	<b>37</b>
---	-----------

## About This Manual...

This manual is included with the Applied Engineering RamWorks II accessory card for the Apple //e. It tells you all about installing and using your RamWorks II card. Don't worry! You don't have to be a programmer to take advantage of RamWorks II's extended memory, 80 column screen display, or other special features, like the Super AppleWorks Desktop Expansion. Everything is explained in this manual.

This manual should provide all of the information required to install and use RamWorks II. If you feel something has been left out or not adequately explained, please let us know.

Here's a summary of what is covered in this manual:

- Chapter 1** is an introduction to the RamWorks II card. It explains what it is and what you need to make it work for you.
- Chapter 2** tells you how to install the RamWorks II in your Apple //e.
- Chapter 3** explains how to use RamWorks II to enhance the performance of AppleWorks.
- Chapter 4** provides information about the use of RamWorks II display features with application programs and system software.
- Chapter 5** contains the instructions on how to use the RamDrive software to utilize the extended memory of RamWorks II to emulate solid state disk storage.
- Chapter 6** provides the necessary information for adding or rearranging memory on RamWorks II and the RamWorks Memory Expander cards.
- Chapter 7** is intended for experienced assembly-language programmers only. It deals with the access and control of RamWorks II bank-switched memory.
- Appendix A** details the special action required when using the RamWorks II with the early Revision A Apple //e Computer.
- Appendix B** contains the instructions for the RamWorks II Memory Test.
- Appendix C** provides an overview of the Applied Engineering RGB Option card for RamWorks II.

### Applied Engineering Technical Support

To assure the utmost in customer satisfaction, Applied Engineering has a staff of technicians dedicated to answering specific technical questions about Applied Engineering products and software. Technical Support representatives are available between the hours of 9 AM to 5 PM CST, Monday through Friday. The Technical Support telephone number is (214) 241-6069. Please have as much information as possible available about your problem if you call. The representative will need to know the following information to effectively answer your question:

- ◇ The Applied Engineering product related to your question.
- ◇ The part number and revision level of your Apple Computer. (See Appendix A.)
- ◇ The configuration of your computer. (What peripherals are being used.)
- ◇ If the question is related to RamWorks II, please provide the revision level, original memory configuration, and current memory configuration of the RamWorks II card.
- ◇ The name, version, and revision level of the software that you are experiencing problems with.
- ◇ The results of any test programs or diagnostics that you may have run.
- ◇ The results of any troubleshooting done by you or your dealer.

## Introduction

### About RamWorks II

RamWorks II is a peripheral card for the Apple //e that not only emulates all of the features of the Apple Extended 80 Column Text card but also allows Apple //e memory to be expanded to up to three megabytes. With the optional RGB Color Option installed, RamWorks II also duplicates all features of the Apple Extended 80 Column Color card. (See Appendix C for details on the RGB option.)

RamWorks II provides a full 80 column by 24 line video screen display and is 100% compatible with all software written for the Apple Extended 80 Column card. Even software written for other memory expansion cards is also compatible with RamWorks II. By using its expanded memory, RamWorks II can be used to enhance application software like AppleWorks, Magic Office System, Flashcalc, Supercalc, and many others. Programs from Applied Engineering, included with RamWorks II, also allow the use of the additional memory to emulate one or more high speed "solid-state" disk drives, called "RamDrives".

### System Requirements:

Simple. All you need is an Apple //e (or the new Enhanced //e) and a video monitor capable of displaying 80 column text.

Most monochromatic computer monitors are able to display 80 column screens. Most TV sets, on the other hand, are not. Televisions are only good for programs using a 40 column text display. The narrower 80 column characters tend to blurr and are very difficult to read when displayed on a TV screen.

**Note:** If your RamWorks II has more than 1.5 Megabytes of RAM installed, Applied Engineering recommends that you protect your system from excessive heat build-up with a cooling fan. These specially designed fans are available from many computer dealers.

### For More information:

In order to install and use RamWorks II you should be at least familiar with how to set up and operate your //e computer and its peripheral devices. Be sure you've read your **Apple //e Owner's Manual**. Especially the section entitled "Meeting Your Apple //e"! Additional valuable information can be found in the following manuals:

**Apple //e Reference Manual** (Apple Computer, Inc.) Contains nuts and bolts information about the bits and bytes of the //e. A must for serious programmers.

**Applesoft Tutorial** (Addison-Wesley Publishing 1-800-238-3801) is a step by step guide for first-time Applesoft BASIC programmers.

**Applesoft BASIC Reference Manual** (Addison-Wesley Publishing 1-800-238-3801) gives in depth details on the Applesoft BASIC programming language. It is intended for serious programmers.

**AppleWorks Reference Manual** (Apple Computer, Inc.) describes all the features of AppleWorks.

**AppleWorks** (Microsoft Press), by Charles Rubin, is an excellent presentation of AppleWorks.

**AppleWorks: The Program for the Rest of Us** (Scott, Foresman, and Company), by Michael L. Sloan, explains not only the features of AppleWorks, but also how to increase the usefulness of AppleWorks.

**ProDOS User's Manual** (Apple Computer, Inc.) provides an overview of Apple's Professional Disk Operating System (ProDOS) and explains how to use the ProDOS User's Disk.

**Beneath Apple ProDOS** (Quality Software), by Don Worth and Pieter Lechner, provides additional information about ProDOS for both the novice Apple user and the advanced programmer.

**Basic Programming with ProDOS** (Addison-Wesley Publishing 1-800-238-3801) gives a more detailed explanation of ProDOS and its commands.

**The DOS User's Manual** (Apple Computer, Inc.) provides an overview of Apple's Disk Operating System (DOS 3.3) and explains how to use the DOS 3.3 System Master Disk.

**The DOS Programmer's Manual** (Apple Computer, Inc.) describes DOS 3.3 and its commands and file structure.

**Beneath Apple DOS** (Quality Software), by Don Worth and Pieter Lechner, is an in-depth presentation of DOS in an interesting and understandable format.

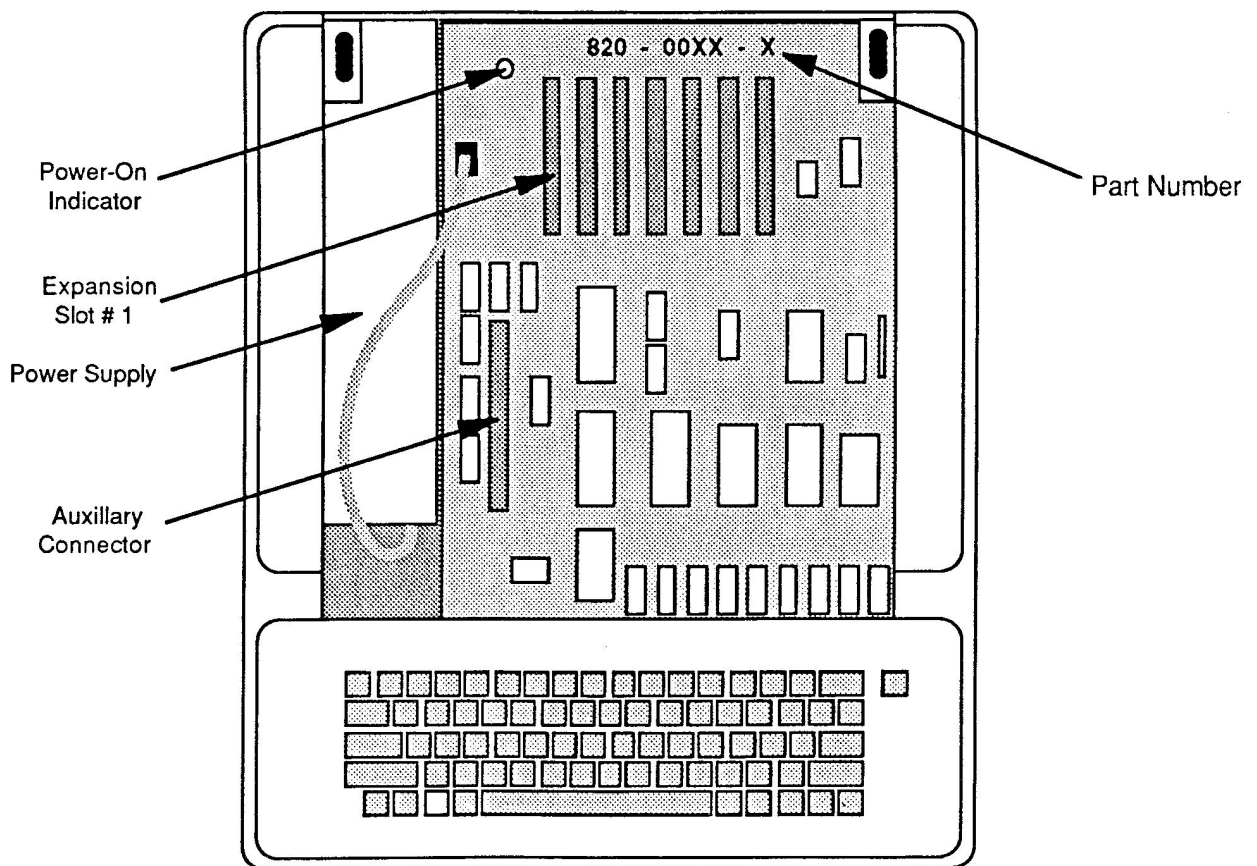


## RamWorks II Installation

### Before You Begin...

There is nothing complicated about installing the RamWorks II. You don't even have to be an Electrical Engineer! If you follow the directions carefully, it should take you no more than a couple of minutes. If you are not familiar with the inside of your Apple //e, please read the chapter entitled "Meeting Your Apple //e" in your Apple //e Owner's Manual. Illustration 2-1, below, points out the //e's components that are important in the installation of RamWorks II.

Illustration 2-1 Inside Your Apple //e



**READ THESE STEP BY STEP INSTRUCTIONS COMPLETELY** before installing your RamWorks II.

- Leave your computer plugged in, but switch the //e power switch to the OFF position.
- Remove the //e top lid.
- Make sure the power-on indicator light inside the computer is OFF. (See Illustration 2-1)
- Check the part number of the computer's main printed circuit board. The part number is between the //e rear panel and expansion slots 3, 4, and 5. If it is 820-0064-B or 820-0087-A go on to the next step. If it is **820-0064-A** please see Appendix A before installing your RamWorks II.
- Discharge any static electricity that may be on your body or clothing by gently touching the power supply.
- Remove the RamWorks II from its anti-static bag. Do not touch the gold edge connectors.
- Position the RamWorks II card above the Auxillary Slot, with the long end of the card toward the rear of the computer.
- Gently but firmly insert gold edge connector of the RamWorks II into the Auxillary Slot.
- Replace the top lid and the installation is complete!

You don't have to test the RamWorks II, but if you'd like to, the instructions are in Appendix B.

---

## AppleWorks and RamWorks II

### Making Great Greater!

AppleWorks is the best selling program from Apple Computer that combines a word processor program, data base program, and a spreadsheet program into one "integrated software package". Evaluated separately, each of these programs would be an outstanding "stand-alone" program, but when combined, AppleWorks becomes an extremely versatile and useful productivity tool. But with a RamWorks II installed, AppleWorks can be extraordinary!

Here's how. AppleWorks uses a portion of the computer's extended memory to store active AppleWorks documents (files). This portion of memory is referred to as the AppleWorks Desktop and its size is expressed in Kilobytes or "K". (A Kilobyte is 1,024 bytes.) With the Apple Extended 80 Column Text card, the Desktop size is limited to only 55K. But, depending on how much memory is installed on your RamWorks II, you could have a Desktop size of 2,277K! Since the AppleWorks program only expects to "see" a 64K extended memory card, the Super AppleWorks Desktop Expander Utility disk, included with your RamWorks II, will enable you to easily modify AppleWorks disks to utilize the extra memory available with RamWorks II.

Here is a list of the AppleWorks enhancements available with the Super AppleWorks Desktop Expander Utility:

- ◊ Improved AppleWorks Speed...Fewer disk drive accesses.
- ◊ More lines in the Word Processor.
- ◊ More records in the Data Base.
- ◊ Greater Spreadsheet capacity
- ◊ Expanded Desktop...To accommodate larger Desktop files.
- ◊ Multiple disk file saving capability...For those larger Desktop files.
- ◊ Built-in printer buffer. (When used with standard printer interfaces.)
- ◊ Optional time display and Data Base time-stamp capability.

### Using the Super AppleWorks Desktop Expander Utility

This program will allow you to modify your AppleWorks STARTUP and PROGRAM disks to take advantage of the RamWorks II's capabilities. It is a one-time only modification. Even if you add or reconfigure memory on your RamWorks II you won't need to run this utility again. (Unless your RamWorks II currently has 128K or less memory installed.) If you already have an Applied Engineering Timemaster II H.O. or any ProDOS compatible clock card, it will allow you to install the AppleWorks Time Utility.

This is what you will need to modify your AppleWorks disks:

- √ An Apple //e with at least one disk drive
- √ A RamWorks II card installed in the Auxillary Slot of the //e
- √ The Super AppleWorks Desktop Expander Utility disk.
- √ A BACKUP COPY of your ORIGINAL AppleWorks STARTUP and PROGRAM disks.

**Do not** modify your ORIGINAL AppleWorks disks! See your AppleWorks Reference Manual or Apple //e Owner's Manual for information on making BACKUP disks.

**Note:** If you are using a non-Apple parallel printer interface card and have AppleWorks version 1.0 or 1.1 you may require a special printer interface "patch" to your STARTUP disk. If your version of AppleWorks requires this interface configuration modification, you should install it before using the Super AppleWorks Desktop Expander Utility. AppleWorks version 1.2 does not require a printer interface patch. (The version number is on the AppleWorks STARTUP disk information screen.) See your Authorized Apple dealer for an upgrade to version 1.2.

"Boot" the Super AppleWorks Desktop Expander Utility in drive one. When the Main Menu appears select the, "Execute AppleWorks Desktop Enhancements" option, and carefully follow the instructions displayed on the screen. Once again, make sure you modify only the BACKUP COPIES of your STARTUP and PROGRAM disks. The features and options available are described briefly on the utility disk's display screens and in greater detail in the next section, entitled "About the New Features".

### About the New Features

The following paragraphs describe the new features of the Enhanced AppleWorks and the instructions for using them. Please read this section very thoroughly.

#### Desktop Expansion

This feature expands the AppleWorks Desktop to accommodate larger files. It increases the number of records in the data base and lines in the word processor and enlarges the Desktop from the standard 55K up to 2,277K, depending on the amount of memory on the RamWorks II card. The Desktop Expansion feature is invoked automatically when the modified AppleWorks program is booted.

#### Multiple Floppy-Disk Files

Data storage problems arise when the size of a file on the Desktop exceeds the amount of storage space on the data disk. A standard floppy disk can store only 135K of AppleWorks data. Using the modified AppleWorks, Desktop files larger than the available disk space, will be segmented, or "split", and saved in sections, to two or more disks. The following paragraphs explain this new feature.

### Saving Desktop Files to Disk

When saving a Desktop file which is larger than the data disk space available, AppleWorks will prompt the user with the following message:

```
Segmented Desktop File...
Please insert NEXT disk with SAME VOLUME NAME
```

Remove the data disk from the current disk drive and replace it with the next data disk. All segments of a given segmented Desktop file **MUST** be saved on data disks having the same volume (disk) name as the primary (first) data disk.

If you discover that you don't have enough formatted blank disks with the same volume name, don't panic! Just use the AppleWorks Disk Formatter utility under the "Other Activities" menu.

In order to enable the multiple disk save capability, one of AppleWorks' safety features had to be overridden. Ordinarily, AppleWorks would save a changed file to the disk before deleting the original file. Now it will replace the original file by writing over it. Pressing the Escape key at any time during a save operation will cancel the save and DELETE the current disk file or file segment on disk. (The Desktop file does remain in memory until removed in the normal manner or power is turned off.) **BE CAREFUL!**

This seems to be a good time to remind you of Murphy's Law:

**Whatever can go wrong will go wrong.**

Back up your Desktop files! It would be a very good idea to have backup copies of your working data disks, especially if you have large amounts of data stored on them. A power failure during a disk save operation could conceivably wipe out months' worth of information!

### Adding multiple-disk files to Desktop

When adding multiple-disk, or segmented, files to the Desktop, the file **MUST** be loaded from the data disks in the same sequence as it was saved. AppleWorks will prompt the user to insert the NEXT data disk(s) until the file is completely loaded.

If you list the files on disks that contain segmented files you will notice that the first segment has the filename that you gave it. The next segment (on the NEXT disk) will have a ".2" appended to the end of your filename. The next disk in the sequence would have a ".3" appended to the filename and so on. This is the way AppleWorks keeps track of the segmented Desktop file sequence. You will probably want to label your data disks in such a way that you too can keep track of the proper sequence.

### AppleWorks Auto-Load feature

AppleWorks was designed for use with only 64K of additional memory, so not all of the PROGRAM disk information is loaded into memory during program startup. Some special "functions", like displaying help screens, adding files, or using the clipboard, are left on the disk and retrieved only when they are needed. If you have a RamWorks II with 256K memory or more you can load these special functions into memory, minimizing the time consuming disk accesses and allowing you to move between Desktop files and AppleWorks' special functions very quickly.

The Auto-Load feature loads all of the AppleWorks special functions into memory along with the rest of the AppleWorks PROGRAM disk. This extends the AppleWorks startup time by about a minute. The PROGRAM disk startup screen will display a counter indicating the number of functions remaining to be loaded. Pressing the Escape key during this count-down will stop the loading of special functions and immediately display the AppleWorks Main Menu. AppleWorks will access the functions in memory that were loaded before the Escape key was pressed and access the PROGRAM disk for those functions which had not been loaded.

The AppleWorks special functions are loaded into RamWorks II memory, but they don't decrease the size of the available Desktop. Magic? Nope! The functions are originally "hidden" in an unused portion of the Desktop memory and as the files on the Desktop grow larger, the special functions are individually "bumped" from memory to make room. If AppleWorks can't find a special function in memory it will go back to the PROGRAM disk.

This brings up an interesting point about using the Auto-Load feature to replace the AppleWorks PROGRAM disk in drive one of a single disk system. If you have all of the special functions Auto-Loaded in memory, you can first specify drive one as the standard location of your data disk and then replace your PROGRAM disk with your data disk. Keep your PROGRAM disk handy, though. You'll need to insert it whenever you print (Open-Apple-P) or change the standard location of your data disk. (The Open-Apple-H print command does not require the PROGRAM disk.) Please refer to your AppleWorks Reference Manual for more details on the selection of a standard location of your data disk.

### Optional Printer Buffer Option

If your RamWorks II has 256K or more of memory the Printer Buffer option will automatically enable you to continue working with files on the AppleWorks Desktop even while your printer is printing.

**Note:** This feature will not work with all printer interfaces. It was designed to work with all standard interfaces supporting the Pascal 1.1 protocol for status checking. If you cannot get this option to work, your interface does not support this official protocol. Contact the manufacturer of your printer card for details on upgrades.

### Optional AppleWorks Time Utilities

This option was designed to utilize the Applied Engineering Timemaster II H.O. (High Output) clock card but it will support all ProDOS compatible clock cards. (The TimeMaster II H.O. has many features that leave the competition far behind!) It will replace the "Open-Apple-? for Help" message in the bottom line of the AppleWorks screen with a current date and time display. This option also allows the AppleWorks user to enter the current date and time into a Data Base category by typing the @ character as the only entry in that category. Note: The category name must contain either the word DATE or TIME, but should not contain both. For example, you should not use this feature in a category named "Date and Time".

## Using RamWorks II

RamWorks II is an accessory card for the //e, and like most other accessory cards, it must be activated (or deactivated) somehow. This chapter provides the essential information for the various methods of activating, deactivating, and controlling the 80 column text features of RamWorks II. Also explained in this chapter are some of the differences between the standard //e 40 column display features and those available with the RamWorks II 80 column screen. The use of the expanded auxiliary memory, from a programmer's standpoint, is explained in Chapter 7 of this manual.

### RamWorks II and Application Software

Programs written for specific purposes such as word processing or record keeping are referred to as commercial or application software. If the application software that you wish to run expects an 80 column text card to be installed in the computer, then RamWorks II 80 column mode is automatically activated. (Unless your particular software package gives you an option for 40 or 80 column screen.) If your software was not designed to take advantage of the 80 column screen features, it will ignore the RamWorks II card and display the screen in the standard 40 column mode.

### Activating RamWorks II with Pascal or CP/M

Both Pascal and CP/M automatically activate the 80 column mode. Just boot your Pascal or CP/M disk in the normal manner.

### Activating RamWorks II using Applesoft BASIC

It is assumed that the user is familiar with the Applesoft BASIC language and the applicable operating system, either DOS or ProDOS, as explained in the Apple //e Owner's Manual. Please refer to Chapter 1 for a list of additional recommended reference sources.

The following is a step by step procedure for activating and deactivating the RamWorks II 80 column firmware from the Apple //e keyboard.

1. Access Applesoft BASIC (with or without DOS or ProDOS). The cursor should be a flashing checkerboard pattern, indicating 40 column mode.
2. Make sure the Caps Lock key is down.
3. Type PR#3 and press the RETURN key to activate 80 column mode. Notice the cursor becomes narrow, solid, and steady (does not flash).
4. To switch to 40 column mode while the 80 column feature is active, press and release the Escape key, then the 4 key. The display is 40 columns wide but the 80 column firmware is still activated. Notice, in this case, the cursor is now wide, solid, and steady. This indicates 40 column mode with 80 column firmware active.

5. To switch back to 80 column display, press Escape, then 8.
6. To deactivate the card completely press the Escape key followed by Control-Q. (Simultaneously pressing the Control and Q keys.) Another way to deactivate RamWorks II is with a Control-Reset, but is not recommended as it could "clobber" your program currently in memory.

A word of caution: Be careful in using PR#0 to deactivate Ramworks II. It may not be advisable to access another slot, PR#1 for example, when the 80 column feature is active. The results can be unpredictable. Escape Control-Q is the recommended way to turn off the card from the keyboard.

### The Escape Mode Features

Pressing the ESC key while in Applesoft BASIC puts the computer into an "altered state" called Escape Mode. While in the Escape Mode some keys take on special meanings. Some keys will execute a certain function then exit the Escape Mode; other keys will allow the Escape Mode to remain active until canceled by the user. The Escape Mode allows control of the Apple //e display and RamWorks II from the keyboard, enables editing programs, and enables correction of typing mistakes. For a more detailed description of the Escape Mode, please refer to the Applesoft BASIC Programmers Reference Manual. For your convenience, the Escape Mode code sequences are summarized in Table 4-1, below.

**Table 4-1 Escape Codes**

Escape Sequence	Function	Notes
Esc @	Clears screen and homes cursor	*
Esc A	Moves cursor right one space	*
Esc B	Moves cursor left one space	*
Esc C	Moves the cursor down on line	*
Esc D	Moves the cursor up one line	*
Esc E	Clears from cursor to end of line	*
Esc F	Clears from cursor to bottom of screen	*
Esc I or Esc ↑	Moves the cursor up one line	**
Esc J or Esc ←	Moves the cursor left one space	**
Esc K or Esc →	Moves the cursor right one space	**
Esc M or Esc ↓	Moves the cursor down one line	**
Esc R	Activates upper-case restrict mode	***
Esc T	Deactivates upper-case restrict mode	***
Esc 4	Switches from 80 to 40 column display	***
Esc 8	Switches from 40 to 80 column display	***
Esc Control-Q	Deactivates the 80 column firmware	***

\* These keys perform their function, then exit the Escape Mode.

\*\* These keys perform their functions and remain in the Escape Mode. The suggested method for exiting Escape mode is to press the SPACE bar once.

\*\*\* These Escape sequences are available in the 80 column mode only.



---

## The Upper Case Restrict Feature

When programming in Applesoft BASIC on an "un-enhanced" Apple //e with the RamWorks II firmware active, you are restricted to using upper case only for program statements. If you were to try using lower case you would get a SYNTAX ERROR. The upper case restrict mode provides an easy way for owners of the un-enhanced //e to use lower case letters in PRINT and INPUT statements.

To activate the upper case restrict mode, press the ESC key then the letter R. Then release the Caps Lock key (up) and enter an Applesoft BASIC program just as you normally would. You will notice that when you type an opening quotation mark, as in the beginning of a string literal (letters enclosed in quotation marks), all the characters which follow will be in lower case. To make one or more of these letters upper case, use the shift key as you normally would. Once you type the closing quotation mark, all letters which follow will be in upper case. To cancel the upper case restrict mode, enter the ESC mode, then type the letter T. The upper case restrict mode remains active until cancelled or the RamWorks II firmware is deactivated.

Owners of the new Enhanced Apple //e will discover that this feature is already built in. All programming can now be done in lower case letters. (Except for DOS 3.3 which still expects its inputs in upper case!) When the program is listed all Applesoft keywords and variable names will then appear in upper case; all literal strings, DATA statements, and REM statements will remain just as originally typed. (Because of this built-in feature Escape-R is not supported on the Enhanced //e.)

## Display Features with RamWorks II

Some Applesoft BASIC commands affect the display screen differently when the RamWorks II firmware is active. The display features affected are HTAB, INVERSE, FLASH, and HOME. Using commas in PRINT statements to tab across the screen is also different when the 80 column firmware is active. To further confuse things, some things aren't different if you have the new Enhanced Apple //e. Read on.

If you're not sure what the commands listed below do or how to use them, please refer to the Applesoft Tutorial or Applesoft Programmer's Reference Manual.

**INVERSE** - When the RamWorks II firmware is off only upper case characters can be displayed in inverse. In the 80 column mode, both upper and lower case inverse characters can be displayed.

**HOME** - With RamWorks II active or inactive, and a NORMAL display (black screen with light letters) the HOME command will clear the screen to black and move the cursor to the upper left corner of the screen. If the HOME command is issued when the RamWorks is active and the display mode is INVERSE, the screen will clear to a light display and show black characters. Turning the RamWorks II firmware off and issuing the HOME command in INVERSE mode will clear the screen to black and remain in the INVERSE mode.

**FLASH** - The flash command will not work in the 80 column mode. If the FLASH command is used when the RamWorks II firmware is active, strange things may happen. To recover from this just use the NORMAL or INVERSE commands.

**HTAB** - This command was originally intended for use with a 40 column display only. Trying to HTAB beyond 40 columns on a standard //e will not work. To position the cursor anywhere on the 80 column line, use the POKE 1403,n command. ("n" is the column number between 1 and 79.) This POKE command will only work when RamWorks II is active. If you have an Enhanced //e, the HTAB command works in both the 40 and 80 column modes.

## Chapter 4

---

Comma Tabbing - Using commas in a PRINT statement to align output into columns only works on a 40 column display. The RamWorks II firmware can be active, but the display must be 40 columns (ESC-4) wide. Unless, of course, you have an Enhanced //e, which supports comma tabbing to a full 80 columns.

### Controlling RamWorks II Display from Applesoft BASIC

When programming in Applesoft BASIC some RamWorks II features can be accessed by using control codes. These codes are actually invisible ASCII characters which have a special meaning to the computer and RamWorks II. Control codes are entered by holding the Control key down while pressing another character key. Another way to issue a control code is from within a BASIC program. Please refer to the Applesoft BASIC Programmer's Reference Manual for more details on control codes and their uses.

Table 4-2 presents a summary of control codes and their functions. Note that some codes can be entered both from the keyboard and from within a program.

**Table4-2 Control Codes**

Control Character	Decimal Code	Function Name	Function	Notes
Control - G	7	Bell	Speaker 1000 Hz tone for 100 mS	
Control - H	8	Backspace	Cursor moves one space left	
Control - J	10	Line feed	Cursor down one line	
Control - K	11	Clear EOS	Clears from cursor to end of screen	1
Control - L	12	Clear	Homes cursor and clears screen	1
Control -M	13	Return	Same as pressing RETURN key	
Control - N	14	Normal	Sets the NORMAL display mode	1,3
Control - O	15	Inverse	Sets the INVERSE display mode	1,3
Control - Q	17	40 Column	Sets the display to 40 columns	1,3
Control - R	18	80 Column	Sets the display to 80 columns	1,3
Control - S	19	Stop list	Stops listing until another key pressed	1,2
Control - U	21	Quit	80 Column mode off	1,3
Control - V	22	Scroll	Scrolls display down one line	1
Control - W	23	Scroll up	Scrolls display up one line	1
Control - Y	25	Home	Homes cursor (does not clear screen)	1
Control - Z	26	Clear line	Clears the line the cursor is on	1
Control - \	28	Forward	Cursor moves one space right	1
Control - ]	29	Clear EOL	Clears from cursor to end of line	1
Control - ^	30	GOTO XY	Uses next two characters, minus 32 as cursor coordinates (Pascal - not BASIC)	1

1. Features available only when 80 column mode is activated.
2. Codes will work only in the immediate mode (keyboard)
3. Codes will work only in the deferred mode (program)

## RamWorks II RamDrive™

### Introduction to RamDrive™

RamDrive is nothing more than a program which allocates all or a specified portion of RamWorks II extended memory (RAM) to be used as one or more "solid-state" disk drives. This program loads itself into a special reserved area of the //e's memory and uses a portion of the RamWorks II memory to store desired programs and files in "disk format". The computer is thereby "tricked" into thinking that it is accessing a disk drive when it is actually retrieving or storing data in memory.

Increased data access speed and potentially greater disk storage capacity make the RamDrive a convenient, low cost alternative to a hard-disk drive. Loading from and saving to a RamDrive can be as much as 20 times faster than a conventional disk drive due to the elimination of the mechanical activity required of a conventional drive. The RamDrive data storage capacity is dependent on the amount of memory available on your RamWorks II.

RamDrive is compatible with almost all DOS 3.3 and ProDOS software available for the Apple //e. Any programs or data files which are not copy-protected can be loaded into a RamDrive and run or accessed just like any other disk drive. A disk which cannot be duplicated with a standard copy program like COPYA or ProDOS volume copy (FILER) is probably copy protected. Although, some copy-protection schemes will allow the program files to be copied from the floppy disk to a hard disk (or RamDrive!) but not to another floppy disk. Due to the rising popularity of hard disk drives and RamDrive software, most software publishers are offering copyable upgrades to their previously copy-protected programs. Check with the software publisher or dealer from whom you purchased the software for details.

RamDrive is a volatile storage medium. Since information stored in a RamDrive is actually stored in RamWorks II memory, when the computer is turned off, the information in the RamDrive disappears. This means you will have to save the data you want to keep to a regular disk drive before turning the computer off.

**Proceed with Caution!** Be careful how you use RamDrives. Although the use of emulated disk drives can appreciably speed up those programs that require frequent disk access, RamDrives can be tricky to use and potentially hazardous to your data. Keep Murphy's Law in mind when you weigh the advantages and disadvantages of using RamDrive software.

The DOS 3.3 version of RamDrive and its utilities are on side one of the RamDrive Program Disk. Side two contains the ProDOS version, ProDrive, and its special utilities. The installation, configuration, and use of these programs and utilities is explained in this chapter.

### RamDrive for DOS 3.3

You don't have to be an experienced programmer to use the RamDrive software but you do have to be familiar with the commands and operation of DOS 3.3. Some knowledge of the Applesoft BASIC programming language is also required. For additional information the following reference manuals are suggested:

**The DOS Users Manual** (Apple Computer, Inc.)  
**The DOS Programmer's Manual** (Apple Computer, Inc.)  
**Beneath Apple DOS** (Quality Software)  
**Applesoft Programmers Reference Manual** (Addison-Wesley Publishing)  
**Apple //e Reference Manual** (Apple Computer, Inc.)

This section explains what the DOS 3.3 version of RamDrive is and how to install and use the emulated disk drive(s). The instructions for the additional programs, SPEEDOS, RAMCOPY, and a specially modified version of FID, included on the DOS 3.3 RamDrive Program Disk, are also provided in this section. This documentation is also available on the RamDrive Program Disk.

#### Description of RamDrive

Depending on the amount of memory (or memory you allocate) on your RamWorks II, the RamDrive software will automatically configure RamWorks II memory to emulate from one to six solid-state disk drives. The storage capacity of the individual RamDrives is dependent on the amount of RamWorks II memory allocated for RamDrive emulation. These disk drives support all DOS 3.3 commands and can be accessed just like conventional DOS 3.3 disk drive(s) by addressing a phantom disk interface card installed in slot 3. For each additional 192K of RamWorks II memory DOS 3.3 will recognize another emulated disk drive. For example, a 512K RamWorks II would be able to emulate one drive (Drive 1) with 744 free sectors, one (Drive 2) with 749, and another (Drive 3) with 239 free sectors. (An initialized DOS 3.3 floppy disk has 496 free sectors; one sector contains 256 bytes of data.) The number of DOS 3.3 files is still limited to 105 per volume (disk). Table 5-1 illustrates RamDrive storage available for various memory configurations.

#### Installing RamDrive

RamDrive (s) can be installed in one of two ways. The first way is to boot side one of the RamDrive Program Disk and select the "Install RamDrive" option from the main menu. The second way would be to load DOS 3.3 into memory and run the RAMDRIVE binary program file. This could be accomplished from within an Applesoft program by inserting the following program line:

```
PRINT CHR$(4); "BRUN RAMDRIVE,S6,D1"
```

This example assumes that the disk with the RAMDRIVE program is in drive one and the disk controller is in slot six. The RamDrive program may be copied to and run from any DOS 3.3 disk and used in your system.

Table 5-1 RamDrive Free Sector Chart

RamWorks II Memory	Free Sectors					
	D1	D2	D3	D4	D5	D6
64K	234					
128K	489					
192K	744					
256K	744	239				
320K	744	494				
384K	744	749				
448K	744	749	239			
512K	744	749	494			
576K	744	749	749			
640K	744	749	749	239		
704K	744	749	749	494		
768K	744	749	749	749		
832K	744	749	749	749	239	
896K	744	749	749	749	494	
960K	744	749	749	749	749	
1024K	744	749	749	749	749	239

## Using RamDrive

If you have only one emulated disk drive (192K or less), then you may access the RamDrive through Slot 3, Drive 1 or 2. You still have only one emulated disk but you need not specify the drive number.

To see that RamDrive is enabled, type CATALOG,S3,D1 in all capitals. The catalog header 'DISK VOLUME 001' will appear on your monitor.

Three methods to transfer files to RamDrive are: loading and saving program files; using the Apple File Developer program (FID); and EXECuting a text file in combination with the FID program.

**LOAD and SAVE method:** Individually LOAD each program from disk and SAVE to RamDrive.

**FID method:** BRUN the FID program found on the Apple DOS 3.3 System Master disk. The FID program is especially useful for transferring binary and text files. The Apple version of FID does not allow addressing drives 3 through 6. A modified FID, which enables specifying drives 1 through 6, is included on the RamDrive Program Disk.

**FID and EXEC file method:** This is a quick way to transfer a selected list of files to a RamDrive. See the DOS Users Manual for more information on EXECuting text files.

An example EXEC file, COPY ALL FILES, is included on the RamDrive Program Disk. This sample file instructs the FID program to copy some of the RamDrive Program Disk's files to RamDrive. To use this sample, boot the RamDrive Program Disk and select the "Copy Files to RamDrive" option. This menu option will automatically run SPEEDOS, install RamDrive, and copy the specified files to RamDrive. Or, this program can be executed by typing 'EXEC COPY ALL FILES,S6,D1' from the Applesoft BASIC prompt. Space permitting, all specified files on the disk (in this example) will automatically be copied to RamDrive in Slot 3, Drive 1.

You must customize COPY ALL FILES for every desired combination of source and destination slots and drives. Customization is easy with any word processor program which saves files to disk in text file format (like DOS 3.3 Applewriter). To further understand how COPY ALL FILES works, use FID to manually transfer some files from S6,D1 to S3,D1; carefully record each keystroke you make, then load the COPY ALL FILES into a word processor and compare it with your keystrokes.

After customizing your own COPY ALL FILES text file, making a turnkey startup disk is easy with the following 'HELLO' program:

```
10 REM Turnkey HELLO program
20 REM FID, RAMDRIVE, COPY ALL FILES, and all files to be copied must be on this disk.
30 PRINT CHR$(4);"BRUN RAMDRIVE"
40 PRINT CHR$(4);"EXEC COPY ALL FILES"
50 END
```

### Activating and Deactivating the RamDrives

The DOS 3.3 'INIT' command does not initialize a RamDrive, it merely deactivates it. It does not install DOS 3.3 or specify a greeting program on the RamDrive. For example, 'INIT HELLO,S3,D1' will disable RamDrive 1, but will not erase any information stored on that RamDrive volume. To reactivate a RamDrive, run the RAMDRIVE program again. All files previously saved on that RamDrive can once again be accessed. RamDrives will also be deactivated by a warm-boot (open-Apple Control-Reset), but can be reactivated by running the RAMDRIVE program.

**Note:** Some application software may use the first 64K (Bank 0 of RamWorks II memory). This conflict with the RamDrive software can cause data on the S3,D1 RamDrive to be "wiped-out". It is a good idea to "lock out" Bank 0 to prevent this from happening. The Bank Lock Out procedure is discussed later in this section.

To erase previous RamDrives and create empty ones, hold the 'solid-Apple' key down while the RAMDRIVE program is running. For example, type 'BRUN RAMDRIVE,S6,D1', hold the solid-Apple key down and press RETURN. Continue holding the solid-Apple key down until the Drive 1 access LED goes out.

### RamDrive Audio-Visual Access Indicators

Just as the red LED on the front of your disk drives indicate a disk access in progress, RamDrive provides a visual access indicator. Whenever DOS 3.3 accesses a RamDrive, an inverse 'R' or 'W' will appear in the lower right corner of the display. The 'R' indicates a disk read operation; the 'W' signifies a disk write operation.

In addition to the visual indicator, an optional audio access indicator is also available. The audio indicator is a high pitched click for a "read from disk" access and a lower pitched click for a "write to disk" operation. To activate the audio indicator option, hold the open-Apple key down while the RamDrive is being enabled. For example, type 'BRUN RAMDRIVE,S6,D1', hold the open-Apple key down, and press RETURN. Continue to hold the open-Apple key down until the Drive 1 access indicator goes out and you hear an audio click. Each audible click indicates a sector read or write operation. You may open-Apple/BRUN RAMDRIVE to activate the audio indicator even if the RamDrive is already enabled.

## Changing RamDrive Parameters

Several modifications can be made to RamDrive to suit the user's needs. The procedure for implementing these modifications is to first 'BLOAD RAMDRIVE' into memory, 'POKE' the new values into specific memory locations, and then 'CALL 24576' to run the RAMDRIVE program. Table 5-2 provides the memory locations, parameters, and initial values for the RamDrive options. The options are explained immediately following the table.

Table 5-2 RamDrive Parameters

Location (decimal)	Initial Value (decimal)	Description
24576		Entry point into RAMDRIVE program
24579	1	80 column option (1=enable; 0=disable)
24580	0	Double Hi-Res option (enable=1; disable = 0)
24581	3	Emulated slot number (1 to 7)
24582	1	Emulated Volume number
24583	24	Duration of read audio indicator (0 to 255)
24584	18	Duration of write audio indicator (0 to 255)
24585	6	Frequency of read audio indicator (0 to 255)
24586	18	Frequency of write audio indicator (0 to 255)
24587	18	Read visual indicator character (decimal ASCII value)
24588	23	Write visual indicator character (decimal ASCII value)
24589	0	Lowest emulated drive number (0 for default or 1 to 3)
24591	15	Directory entries + 7 for emulated drive 1 (1 to 15)
24592	15	Directory entries + 7 for emulated drive 2 (1 to 15)
24593	15	Directory entries + 7 for emulated drive 3 (1 to 15)
24594	15	Directory entries + 7 for emulated drive 4 (1 to 15)
24595	15	Directory entries + 7 for emulated drive 5 (1 to 15)
24596	15	Directory entries + 7 for emulated drive 6 (1 to 15)
24597	0	Bank lock out bit map for banks 8 through 15
24598	0	Bank lock out bit map for banks 0 through 7

**Note:** If a RamDrive is currently active, you must re-install the RamDrive before any modifications will have any effect. This can be accomplished by the 'CALL 24576' statement.

### 80 Column and Double High Resolution Graphics

The 80 column and double high resolution screen displays reside in Bank 0 (64K) of the RamWorks II card. If you "lock out" this bank from being used by RamDrive, the 80 column and double hi-res can always be utilized regardless of the parameter values in locations 24579 or 24580.

Otherwise, the default values for these parameters allow the use of the 80 column screen and disallow the the use of the double high resolution screen feature. If a disallowed display is used anyway, parts of the data on the first RamDrive will be "clobbered". If you will not require the 80 column display and want to gain an additional 4 sectors of RamDrive space, enable RamDrive with Applesoft statements like these:

```
100 PRINT CHR$(4);"BLOAD RAMDRIVE,S6,D1"
110 POKE 24579,0:CALL 24576:REM This will disallow 80 columns
```



## Chapter 5

---

To use the double high resolution graphics display, which displaces 8K (32 sectors) of RamDrive space, change line 110 to:

```
110 POKE 24580,1:CALL 24576:REM Allow use of Double Hi-Res
```

### Emulated Slot

This option allows you to specify the slot in which the "phantom" RamDrive controller card is installed. Slot 3 is the default value, as table 5-2 indicates, but any slot between 1 and 7 (regardless of any other cards installed) could be selected by changing the value at location 24581. If the emulated slot is also the actual disk controller slot, slot 6, for example, then S6,D1 would be the only physical drive and drives 2,3,...6 would be the emulated drives. The physical drive 2 in slot 6 would be ignored in this case.

### Lowest Drive Number

The value in location 24589 is used to set the lowest emulated drive number. With reference to the emulated slot 6 example above, if the lowest drive value was changed to 3, the physical slot 6 drives would be drives 1 and 2. The emulated drives would then be drives 3, 4, 5, & 6. (assuming sufficient RamWorks II memory)

### Emulated Volume Number

This contents of this memory location specifies the volume number of the first emulated drive. Subsequent emulated drives will have a volume number one greater than the preceding volume.

### Read and Write Visual Access Indicators

The default indicators can be changed from 'R' and 'W' to any other characters by POKE-ing the appropriate decimal ASCII value into the corresponding memory location. The visual indicators can be effectively disabled by changing the values at 24587 and 24588 to 160 (the high ASCII SPACE character).

### Directory Entries

You may specify the maximum number of files (directory entries) allowed on each emulated RamDrive. Divide the number of desired directory entries by seven and enter the integer value in the memory location corresponding to the emulated drive number. (see Table 5-2) The default value provides for 105 directory entries ( $105 \div 7 = 15$ ). The minimum allowed is 7 files; the maximum is 105. Obviously, fewer directory entries specified yields more emulated disk data storage space. Up to 14 additional sectors can be gained per drive.

### Audio Access Indicators

The duration and frequency of the optional audible read and write access tones can be adjusted by varying the values in locations 24583 through 24586.

### Bank Lockout

RamWorks II memory is organized into memory "banks", each containing 64K bytes of data. Depending on the amount of memory installed on RamWorks II, up to 16 banks can be used for RamDrive emulation. By default, the RamDrive program determines how many RamWorks II banks are available and automatically



configures all of them for use as emulated disk storage. If you wish to allocate some banks for other purposes, RamDrive provides the capability of locking out specified banks. Information stored in banks that are locked out is not modified by RamDrive. The bank lock out feature allows the division of RamWorks II memory among other programs and operating systems.

**Note:** The numbering scheme for RamWorks II memory banks is determined by the type of RAM chip (64K or 256K), the memory blocks used, and the amount of RAM installed. See Chapter 6, RamWorks II Memory Configuration, for more details.

To lock out an individual bank from bank 0 to bank 7, raise 2 to the power of the bank number to be locked out and POKE the result in location 24598. For example, to lock out bank 0:  $2^0 = 1$ ; POKE 24598,1

To lock out more than one bank in the bank 0 to 7 range, POKE the sum of the individual bank results. For example, to lock out banks 0 and 3:

$$(2^0 + 2^3) = (1 + 8) = 9; \text{ POKE } 24598,9$$

To lock out a bank or series of banks in the bank 8 to 15 range, apply the same formula except divide the sum of the results by 256 and POKE the final result in location 24597. For example, to lock out banks 8 and 9:

$$(2^8 + 2^9) + 256 = (256 + 512) + 256 = 3; \text{ POKE } 24597,3$$

## RamDrive Technical Information

The following information is intended for hard core programmers only. Don't blame us if your mind turns to mush after reading this section.

- ◇ After enabling the RamDrive, a PEEK(24590) statement will indicate the highest emulated drive number ( 0 - 5) available. A value of 0 in this location indicates the drive specification from the IOB to be ignored (1 drive). Together with the lowest emulated drive number found in location 24589, you can find out how many RamDrives you have available.
- ◇ A PEEK to location 24599 will return the number of 64K banks ( 0 to 15) used by RamDrive. This number may be less than the amount of memory on the RamWorks II card if some banks have been locked out.
- ◇ A list of specific banks used by RamDrive can be found in memory locations 24600 to 24615. A value of 255 signifies no bank.
- ◇ Some DOS 3.3 enhancement programs and utilities may not work with RamDrive installed. Utilities which relocate DOS 3.3 into high memory will not work with RamDrive.
- ◇ Track 1 and track 17 map to the same memory. Unused sectors on the directory, track 17, are used in track 1.
- ◇ The RamDrive program resides from \$6000 to \$64E7. This memory is freed after RamDrive is enabled. RamDrive uses DOS 3.3 unused memory from \$BCE0 to \$BCFF and overwrites the first 4 bytes of the RWTS routine at \$BD00. If the highest emulated drive number is greater than 2, DOS 3.3 is patched at \$A9B5. When the INIT command is issued, all patches to DOS 3.3 are removed, disabling the RamDrive.

- ◇ The RESET vector from page 3 points to a patch area above the RWTS in DOS 3.3. The purpose is to enable 64K bank 0, if it is not already, whenever the RESET key is pressed. Use care in changing the RESET vector after RamDrive is enabled.
- ◇ After each disk access to RamDrive, the bank switched memory (\$D000 to \$DFFF in main memory) will be left in the following conditions:
  - RAM bank 2 will always be write enabled.
  - ROM will be read enabled if Applesoft was in use prior to the disk access.
  - RAM bank 2 will be read enabled if Applesoft was not in use.

These rules insure that Applesoft and Integer BASIC and other programs using bank switched memory will work properly.
- ◇ The RWTS routine may be called at \$3D9 as described in the DOS Programmer's Manual noting the following exceptions:
  - The IOB and buffer must reside in the memory range from \$200 to \$BFFF.
  - Track numbers may range from 1 to 49 only. If an I/O error results, you may have too little memory for the requested track on that drive. All non-existent or reserved tracks and sectors are flagged in the VTOC.
  - Sector numbers may range from 0 to 15

### RAMCOPY Instructions

RAMCOPY is a disk duplication utility for the Apple //e with a RamWorks II card installed. It decreases the number of disk swaps required during disk duplication by using the extra memory available on RamWorks II to store more of the source disk data in one pass. Its operation is similar to Apple's COPYA which uses the //e's main memory only.

RAMCOPY is a binary file and can be executed with the BRUN command or selected from the main menu of the RamDrive Program Disk. Slot 3, or an emulated RamDrive, cannot be specified as either the original or duplicate slot. RAMCOPY will copy standard DOS 3.3, ProDOS, Apple Pascal 1.1, and CP/M disks.

**WARNING!** RAMCOPY uses the first two 64K banks it finds on RamWorks II. It will wipe out any RamDrive information that is stored in these banks. To prevent this from happening, lock out these banks from RamDrive. RAMCOPY will also disable RamDrive, requiring you to reactivate the RamDrive.

### SPEEDOS Documentation

This DOS 3.3 speed-up utility, included on the RamDrive Program Disk can make DOS 3.3 run up to 40 times faster using it in combination with a RamDrive! It is a public domain program written by Lee DeRaud and published in Call A.P.P.L.E.

Use FID to copy SPEEDOS onto your startup disks. SPEEDOS can be enabled by typing 'BRUN SPEEDOS' at the Applesoft prompt or from within a greeting program.

SPEEDOS modifies only the "image" of DOS 3.3 in memory; it does not modify DOS 3.3 on the disk. When SPEEDOS is enabled, the INIT command is disabled. RamDrive will also be unable to load or save files outside the memory range from \$200 to \$BFFF when SPEEDOS is installed.

## ProDrive™ for ProDOS

### Introduction to ProDrive™

ProDrive is the ProDOS version of RamDrive. It is not difficult to use, but you should be familiar with the ProDOS commands and file structure, and the Applesoft BASIC programming language. The following documents are recommended for additional information:

**The ProDOS User's Manual** (Apple Computer, Inc.)  
**BASIC Programming With ProDOS** (Addison-Wesley Publishing)  
**Beneath Apple ProDOS** (Quality Software)  
**Applesoft Programmer's Reference Manual** (Addison-Wesley Publishing)  
**The Apple //e Reference Manual** (Apple Computer, Inc.)

This section provides a description of the ProDrive emulated disk drive and explains how to install, configure, and use it. Instructions for creating a turnkey file copy utility are also included in this section. This documentation is also available on the ProDOS side of the RamDrive Program Disk.

### Description of ProDrive

When ProDOS is loaded into the Apple //e's memory it automatically recognizes the 64K "bank 0" of the RamWorks II extended memory as an emulated ProDOS volume (disk) with a volume name of '/RAM'. The PRODRIVE program on side two of the RamDrive Program Disk can enable all or a combination of additional RamWorks II memory banks for use as a larger emulated ProDOS volume. The size of this emulated volume is dependent on the amount of available RamWorks II memory and the number of banks locked out. The ProDrive fully emulates a ProDOS volume (initially named '/RAM') in slot 3, drive 2.

### Installing ProDrive

The ProDrive can be created in one of two ways. The first way is to boot side two of the RamDrive Program Disk and select the "Install ProDrive" option from the main menu. The second way would be to load ProDOS into memory and run (BRUN) the PRODRIVE binary program file. This could be accomplished from within an Applesoft startup program by inserting the following program line:

```
10 PRINT CHR$(4);"BRUN PRODRIVE"
```

### Accessing ProDrive

The ProDrive emulated disk drive supports all ProDOS commands and protocol. Files can be renamed, saved to, loaded from, and deleted from the ProDrive just like a conventional ProDOS volume.

ProDOS files can be copied to and from the ProDrive using Apple's FILER program included on the ProDOS side of the RamDrive Program Disk. See the ProDOS User's Manual for FILER instructions. When using the FILER do not use the 'FORMAT A VOLUME' or 'COPY A VOLUME' on a ProDrive. These options do not work on an emulated disk drive.

### Bank Lock Out Feature

When the ProDrive is initially created by the PRODRIVE program, the 64K bank 0 is locked out. That is, the ProDrive cannot access that particular bank for use as part of the emulated disk drive. The bank 0 lock out default was used to allow other application programs which use that bank to be run without conflicting with the ProDrive. With ProDrive installed and bank 0 locked out, ProDOS based programs can run, using bank 0 and also accessing the ProDrive.

**Caution:** The bank lock out procedure described in this section is more complicated than it sounds. Don't attempt it unless you are very familiar with Applesoft BASIC and your disk operating system(s). Instead, you may wish to use the PARTITION program described later in this chapter.

If you wish to lock out additional banks of RamWorks II memory or use all of the available banks, you must make one or two simple modifications to the PRODRIVE program. This involves calculating the values used to lock out the desired banks, loading the PRODRIVE program into memory, inserting those values into specific memory locations, and executing the modified PRODRIVE program.

**Note:** The numbering scheme for RamWorks II memory banks is determined by the type of RAM chip (64K or 256K), the memory blocks used, and the amount of RAM installed. See Chapter 6, RamWorks II Memory Configuration, for more details.

There are two memory locations associated with modifying the number of banks locked out. These are (decimal) 8195 for banks 0 through 7 and 8196 for banks 8 through 15. To lock out an individual bank from bank 0 to bank 7, raise 2 to the power of the bank number to be locked out and POKE the result in location 8195. For example, to lock out bank 0:

$2^0 = 1$ ; POKE 8195,1

To lock out more than one bank in the bank 0 to 7 range, POKE the sum of the individual bank results. For example, to lock out banks 0 and 3:

$(2^0 + 2^3) = (1 + 8) = 9$ ; POKE 8195,9

To lock out a bank or series of banks in the bank 8 to 15 range, apply the same formula except divide the sum of the results by 256 and POKE the final result in location 8196. For example, to lock out banks 8 and 9:

$(2^8 + 2^9) + 256 = (256 + 512) + 256 = 3$ ; POKE 8196,3

To execute the now modified PRODRIVE program issue a CALL to location 8192.

The following is a summary of Applesoft BASIC statements to lock out banks 0, 3, 8, and 9 as in the example above.

```
JBLOAD PRODRIVE
JPOKE 8195,((2^0) + (2^1))
JPOKE 8196,(((2^8) + (2^9))/256)
JCALL 8192
```

Or, as part of a BASIC startup program, this example could appear:

```

]10 PRINT CHR$(4);"BLOAD PRODRIVE"
]20 POKE 8195,(((2^0) + (2^1))
]30 POKE 8196,(((2^8) + (2^9))/256)
]40 CALL 8192

```

The bank lock out feature also allows RamWorks II memory to be shared by ProDOS and different application programs and/or disk emulation programs under different operating systems (like DOS 3.3). To do this, you must first determine which banks you wish to lock out by referring to "Bank Configuration" in Chapter 6. Next you will need to install the disk drive emulator for the 'first' operating system, such as RamDrive for DOS 3.3, locking out those banks to be used by the 'second' operating system (ProDOS). Finally, install the ProDrive disk emulator, which will utilize those banks which were not locked out in the previous step.

**Note:** Executing the PRODRIVE program will create an emulated ProDOS volume and automatically initialize (clear) the '/RAM' volume directory. When re-executing PRODRIVE, holding the Closed-Apple Key down while the PRODRIVE program is running (about 5 seconds) will activate the ProDrive but will not re-initialize the previous ProDOS directory. All information previously stored in that ProDrive can again be accessed.

## Using the PARTITION Program

There is an easier way to lock out banks! The PARTITION program on side two of the RamDrive Program Disk is a menu-driven utility that will reconfigure the bank lock out parameters within the PRODRIVE program. PARTITION causes the specified lower numbered 64K banks of available memory to be locked out from use by the ProDrive. PARTITION can also modify a COPY of your AppleWorks STARTUP disk to be compatible with and use the installed ProDrive as well as use the locked out memory for expanding the AppleWorks Desktop. The instructions for this utility will appear on the screen when the program is run.

Here's an example of a way to build an AppleWorks STARTUP disk that will install a ProDrive before booting AppleWorks. First, use the FILER to format a blank disk (any volume name except /APPLEWORKS), then copy the following files, in the order listed, to that disk. From the ProDOS side of the RamDrive Program Disk copy PRODOS, BASIC.SYSTEM, and PRODRIVE. Copy APLWORKS.SYSTEM and SEG.00 from an AppleWorks startup disk. Be sure to copy BASIC.SYSTEM prior to APLWORKS.SYSTEM. (You want ProDOS to execute BASIC.SYSTEM first.) Use the FILER to rename this disk '/APPLEWORKS' and save the following program as the STARTUP program.

```

10 PRINT CHR$(4);"- PRODRIVE"
20 PRINT CHR$(4);"- APLWORKS.SYSTEM"

```

Boot the ProDrive side of the RamDrive Program Disk, exit to BASIC, and run the PARTITION program. Select option 'A' (for AppleWorks); use the left and right arrow keys to adjust the ProDrive and Free Memory size. Insert the modified AppleWorks STARTUP disk and enter '/APPLEWORKS/PRODRIVE' at the ProDrive prompt. Enter '/APPLEWORKS/APLWORKS.SYSTEM' at the APLWORKS.SYSTEM prompt.

## Chapter 5

---

This STARTUP disk, when booted, will lock out the lower 64K banks specified for use by AppleWorks (free memory) and install a ProDrive (/RAM) in the available upper banks. The modified AppleWorks STARTUP disk is now patched to use only up to the amount of memory you specified in the PARTITION program.

### Instructions for COPY.FILES

Included on side two of the RamDrive Program Disk is an Applesoft BASIC utility program which can enable you to list the specific files you wish to load into your ProDrive. This program can also load files from several different ProDOS volumes. COPY.FILES can be used as a ProDOS STARTUP program which will automatically load files into the ProDrive. This program assumes the ProDrive volume name is 'RAM'.

Selecting the "Copy Files to ProDrive" option from the ProDrive main menu will install and initialize a ProDrive, RUN the COPY.FILES program, and copy the files specified in the program's DATA statements to 'RAM' (program lines 10010 to 10390). Tip: See the note, above, about retaining information already stored in the ProDrive.

The COPY.FILES program can also be RUN from Applesoft BASIC, but only after the ProDrive has been created. If the ProDrive has not been installed, COPY.FILES will attempt to copy the specified files into the 64K ProDOS 'RAM' volume.

To illustrate the proper format of the DATA statements let us use the sample statements currently in the program. Line 10010 contains the number of files to be copied from the volume indicated after the comma in the same line. The volume name must include the leading and ending '/' pathname delimiters as in the example below. This line establishes the ProDOS prefix for the filenames listed in the next 8 DATA statements.

```
J10010 DATA 8,/PRODRIVE.LO/  
J10020 DATA PRODOS  
J10030 DATA BASIC.SYTEM  
J10040 DATA STARTUP  
J10050 DATA GET.LEN  
J10060 DATA PRODRIVE.DOC  
J10070 DATA COPY.FILES.DOC  
J10080 DATA PRODRIVE  
J10090 DATA FILER  
J10100 DATA 0,/END/  
J10120 DATA  
.  
.  
.  
J10390 DATA
```

Line number 10100 in this example informs the COPY.FILES program that there are no more files to copy. This statement is required to properly end the COPY.FILES program. If you were to change this line to read 'DATA 4,/XYZ/' the program would prompt you to insert the volume named 'XYX' and proceed to copy from it the 4 files you had listed in the next four DATA statements.

After all files listed in the DATA statements have been copied to the ProDrive, 'COPY COMPLETE' will be displayed and the computer will return to the Applesoft BASIC mode.

---

## RamWorks II Memory Configuration

### Introduction

This chapter provides the information required to add and configure memory on your RamWorks II and RamWorks Memory Expander cards. It contains the specifications for the RAM (Random Access Memory) chips, tells where you can get them, and then, how to install them. The procedure for installing the RamWorks Memory Expander onto RamWorks II is also included in this chapter.

**Warning!** Don't ZAP your chips! There are many static sensitive components in the //e, on the RamWorks II, and Memory Expander cards. Be very careful to discharge any static electricity on your body by touching the //e power supply case before touching any of the components!

### The Proper Memory Chips

Selection of the proper RAM chips for RamWorks II can be tricky. There are several chip manufacturers and many different types and specifications of chips available. RamWorks II and the RamWorks Memory Expander card can use either 64K or 256K RAM Dual In-Line Package (DIP) chips. They must be DYNAMIC RAM chips and have a speed specification of 200 nS (nanoseconds) or faster. Applied Engineering recommends a rating of 150 nS.

The RamWorks 2 Meg Memory Expander uses a very special, limited production 24 pin dual-sided 256K x 8 Single In-Line Package (SIP) RAM chip. The recommended chip speed specification is also 150 nS.

The 64K and 256K memory chips with the correct specifications can be obtained at some computer or electronics parts stores. Or you can get them through Applied Engineering; probably at lower cost. The 256K x 8 memory chips are available commercially but they are extremely expensive when purchased in small quantities. Since Applied Engineering gets bulk-quantity discounts on its purchases of memory chips, they can offer them at lower prices. Applied Engineering uses only the highest quality memory chips and will warrant them for 5 years. (Most electronics parts vendors sell their chips "as is".) With Applied Engineering memory chips you are also assured of getting the right chips.

### Memory Chip Installation

**Note:** You may return your RamWorks II and/or RamWorks Memory Expander to Applied Engineering for a memory upgrade with no additional charge for the installation or testing. Call Applied Engineering Technical Support for the latest memory chip prices and get a Return Material Authorization (RMA) number. The Technical Support telephone number is (214) 241-6069.

The main RamWorks II card can have from 64K to 1024K of memory installed using 64K chips, 256K chips, or a combination of both. (If your RamWorks II replaces an Apple Extended 80 Column Text card, you may be able to install the Extended 80 Column card's 64K chips on your RamWorks II.) The memory on RamWorks II is organized into 4 "blocks", designated block A, B, C, and D. Illustration 6-1 shows which



memory chip sockets are allocated to each block. Each block must be either completely empty or completely populated with 8 chips of the same memory size. NEVER mix 64K chips and 256K chips in the same block!

Illustration 6-1 RamWorks II Memory Blocks

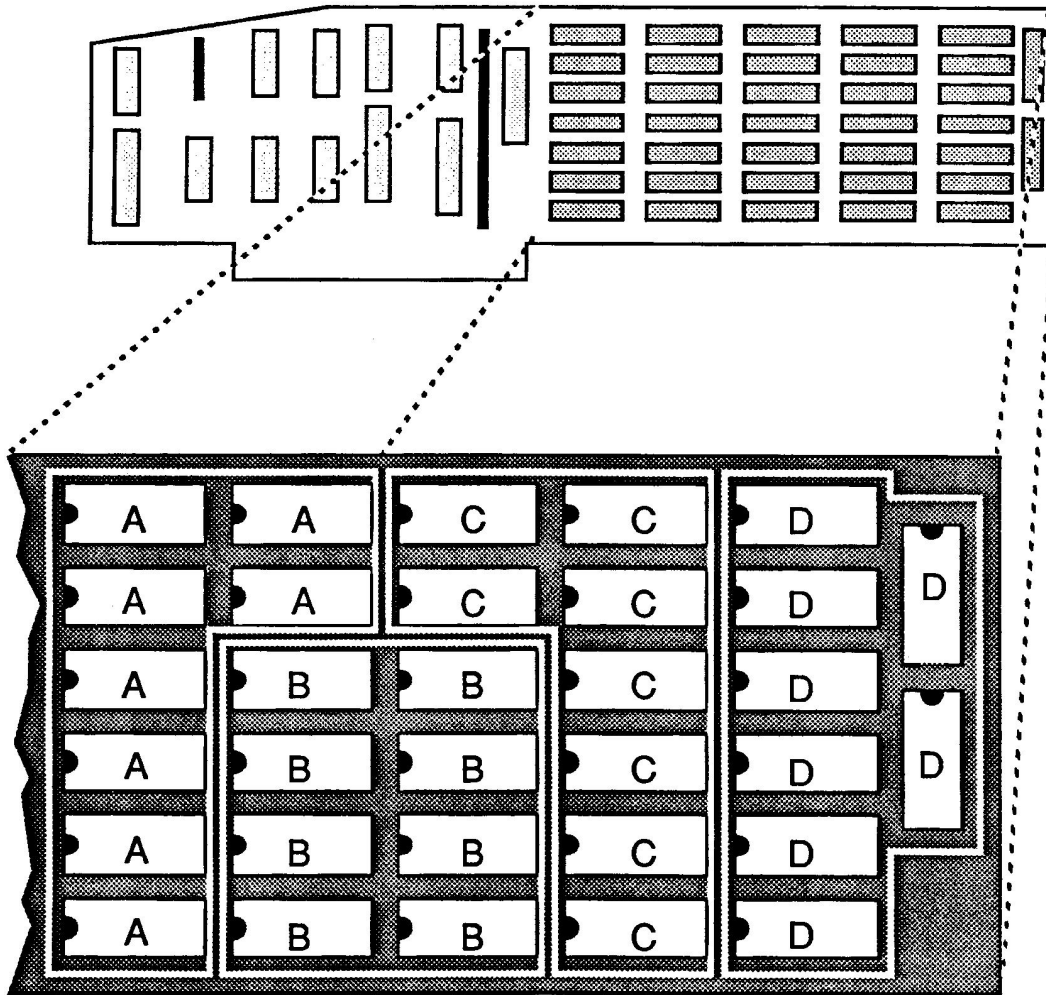


Illustration 6-1 shows the correct orientation of the RAM chips on the RamWorks II card. Note the position of the notch (or dot on some chips). It is extremely important to insert the memory chips properly. Each RAM chip should have all legs fully seated in the socket and in the correct position.

**OOPS!** If power is applied to a chip that is plugged in backwards, the chip will be ruined immediately, but don't worry, RamWorks II is tough, it will survive.

The RamWorks 512K Memory Expander "piggy-back" card can have from 64K to 512K installed using the 64K chips, 256K chips, or both. RAM on the 512K Memory Expander is organized into two blocks, E and F. Illustration 6-2 shows the correct RAM chip orientation and block designations for the 512K Memory Expander. Don't mix 64K and 256K chips in the same block on the Expander card either!



Illustration 6-2 RamWorks '512K' Memory Expander

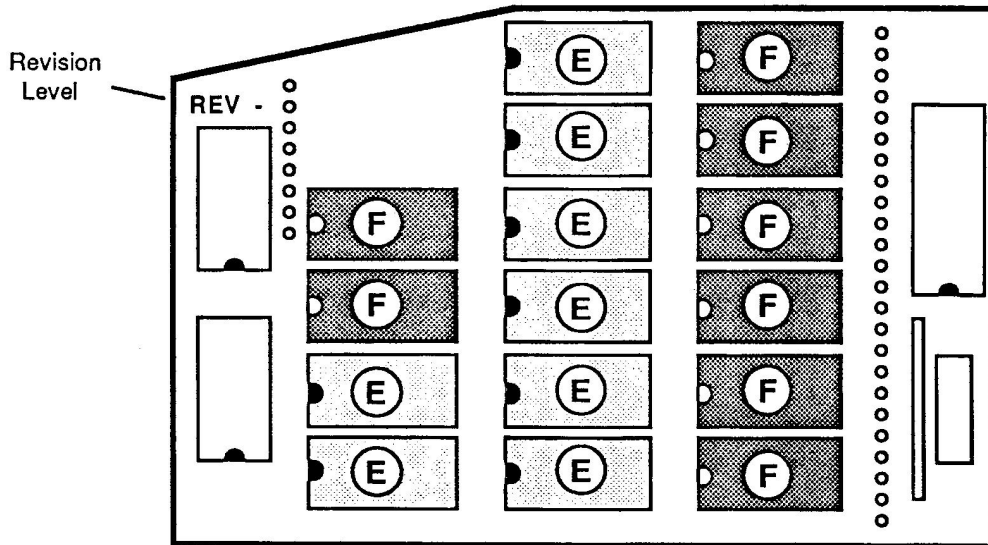


Illustration 6-3 RamWorks '2 Meg.' Memory Expander

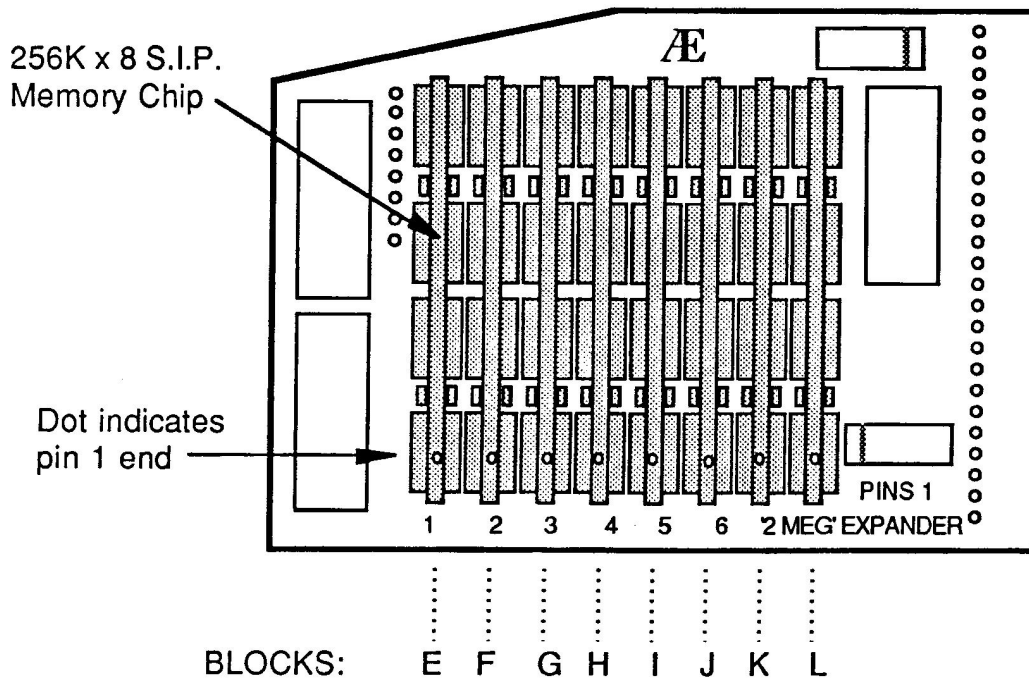


Illustration 6-3 shows the 2 Meg. RamWorks Memory Expander which uses the new Single In-Line package (SIP) 256K x 8 RAM chips. Note that each chip is one block.

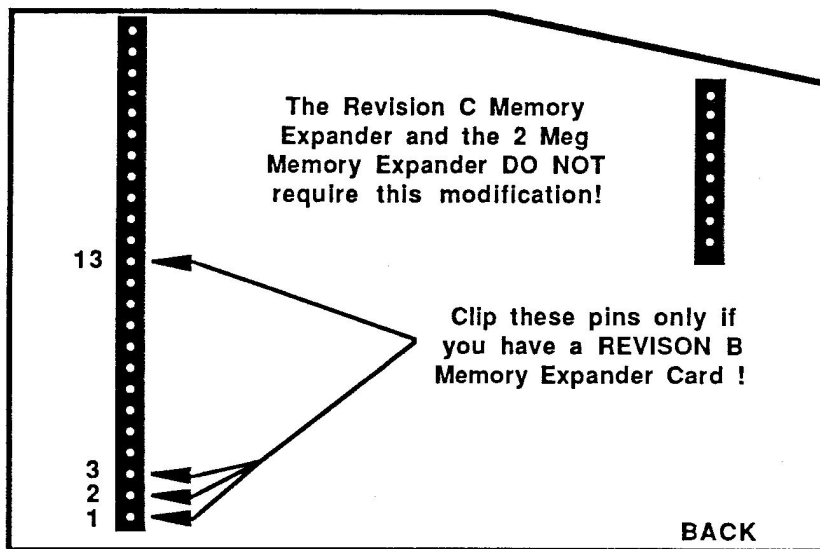
### Installing the RamWorks Memory Expander Card on RamWorks II

If you are installing a 512K RamWorks Memory Expander, you must first determine the revision level of the Expander card. The revision letter is located on the upper, keyboard end of the component side (the side with the chips) of the Expander. See Illustration 6-2.

If you have a revision B Expander you will need to perform some minor surgery on it before installing it on your RamWorks II. The only tool required is a small wire cutter. Locate pins 1, 2, 3, and 13 on the larger row of pins and clip them flush with the black sleeve. (See Illustration 6-4) Pins 1, 2, and 3 are easy, but count carefully when you clip 13! The pins take a long time to grow back.

The Revision C 512K Expander card and the 2 Meg Expander card **do not** require this modification!

Illustration 6-4 Revision B 512K Expander Modification



Back (solder) Side of the Revision B 512K Memory Expander

To install the Memory Expander onto the main RamWorks II card, first **TURN OFF THE POWER SUPPLY** and remove the RamWorks II card. Carefully line up the pins on the underside of the Memory Expander with the corresponding sockets on the **COMPONENT** side of the RamWorks II card. Press them gently but firmly into the sockets until they are fully seated. (Even when it's fully seated there may still be some of the pin showing between the connectors, so don't press too hard!) Now, re-install the Expanded RamWorks II, following the instructions in Chapter 2.

Table 6-1 RamWorks II Bank Configuration Chart

RamWorks II Main Board:	RAM Chip		Bank Numbers (decimal notation)			
	Block	Size				
A	64K	00	-	-	-	
	256K	00	01	02	03	
	64K	04	-	-	-	
	256K	04	05	06	07	
C	64K	08	-	-	-	
	256K	08	09	10	11	
D	64K	12	-	-	-	
	256K	12	13	14	15	
512K Memory Expander:	Block	Size	Bank Numbers			
E	64K	16	-	-	-	
	256K	16	17	18	19	
F	64K	20	-	-	-	
	256K	20	21	22	23	
2 Meg. Memory Expander:	Block	Size	Bank Numbers			
E	256K x 8	16	17	18	19	
F	256K x 8	20	21	22	23	
G	256K x 8	48	49	50	51	
H	256K x 8	52	53	54	55	
I	256K x 8	80	81	82	83	
J	256K x 8	84	85	86	87	
K	256K x 8	112	113	114	115	
L	256K x 8	116	117	118	119	

### Memory Bank Configurations

Table 6-1 shows the relationships between memory blocks, banks, and memory chip size for RamWorks II, the RamWorks 512K Memory Expander, and the 2 Meg Expander. From this table you can determine the addressable 64K banks for any possible configuration of memory chips. The bank designations are in decimal notation.

Another way to determine what banks are available on your RamWorks II and optional RamWorks Memory Expander, is to run the RamWorks Memory Test on the Super AppleWorks Desktop Expander Disk. The test will display the valid banks found on both memory cards. (Please note that the bank numbers are referenced in hexadecimal notation.)

**Note:** When installing or rearranging RamWorks II memory chips, it is suggested that you install the larger (256K) chips in block A, filling up the lower banks of memory first. Use the 64K chips in the blocks immediately after the blocks with 256K chips. Some software packages that utilize extended memory will "look" for the extended memory only in the lower banks.

## RamWorks II Auxillary Memory

### For Programmers Only...

Since RamWorks II is completely compatible with the Apple Extended 80 Column card, the purpose of this chapter is to describe only the feature which is unique to RamWorks II, extended auxillary memory. This material is definitely intended for assembly language programmers. Information concerning the access and control of the 80 column firmware, screen features, and auxillary memory can be found in the **Apple //e Reference Manual**.

**Warning:** Don't attempt to use the auxillary memory directly from an interpreter such as BASIC or Pascal. These interpreters use certain portions of main memory that, when switched to auxillary memory can cause your program and the interpreter to "bomb".

### Bank Switching

The 6502 microprocessor has the address capability of only 64 kilobytes. In order to address more memory, a feature built in to the Apple //e's firmware called "bank switching" is used. Soft switches control whether the 6502 is addressing the 64K bank of main memory or the single 64K bank of auxillary memory available with the Extended 80 Column card. In order to use more than just 64K of auxillary memory RamWorks II combines this bank switching technique with its own firmware feature called the bank select register. The bank select register determines which of 48 possible 64K banks of auxillary memory the 6502 is addressing.

The bank select register is mapped into the //e's memory space at location \$C073 (49267). The programmer can select one of 48 valid banks by writing the bank number into this location. (Chapter 6 provides the bank numbers for various memory configurations.) Once the bank selection has been made, soft switches built into the //e firmware function as they normally would. This allows data to be transferred from main memory to auxillary memory and vice versa.

Data transfers between banks of auxillary memory must be done in two stages. The first step is an intermediate transfer to main memory, then from main memory to the desired bank(s). Transfer can also be accomplished, one byte at a time, using the Accumulator.

Bank 0 in RamWorks II always contains the text information for the 80 column display and the graphics information for the double high resolution display. This bank must be active whenever the program updates the display screen. Since the video information is contained only in bank 0, this feature, unique to RamWorks II, eliminates a screen flicker problem inherent with some other brands of memory cards when they access other banks.

The bank select register is initialized to zero on a power-up, but not after a reset. Please refer to the programming suggestion on "Reset Vector".

The location of the bank select register is also shared with the system. Writing to the bank select register

## Chapter 7

---

will also trigger the paddle strobe, which is used to read the paddle inputs. To insure the paddles are read correctly, wait at least 3 milliseconds after changing banks before starting the paddle read routine.

The contents of the bank select register cannot be read. The program must keep track of the current bank number in a reserved location within each bank.

### Programming Suggestions

#### Interrupts

Programmers should be aware that RamWorks II has multiple interrupt vectors. Since the interrupt vector is located at \$FFFE, each auxillary bank of memory contains an interrupt vector. Auxillary memory may be switched in when an interrupt occurs; therefore, routines that use auxillary memory should be prepared to disable or process interrupts. It is recommended that interrupts be disabled in programs not requiring their use. Please refer to the Apple //e Reference Manual for details on handling interrupts.

#### Reset Vector

All programs should start by initializing the bank register to 0 (video bank). Since RamWorks II cannot detect a hardware reset, the software should be able to handle a reset by storing a 0 in the bank register. The following assembly language subroutine intercepts the reset soft vector at \$3F2-\$3F3 and changes it to point to the new reset routine.

```
*Store off old reset soft vector
    LDA    $3F2
    STA    $300           ;IN $300.301
    LDA    $3F3
    STA    $301

*Set reset vector to point to $302
    LDA    #$02
    STA    $3F2           ;($3F2 -> $302)
    LDA    #$03
    STA    $3F3
    EOR    #$A5           ;Inits new validity check byte
    STA    $3F4

*Reset routine
    LDA    #$A9           ;LDA #0
    STA    $302
    LDA    #$0
    STA    $303
    LDA    #$8D           ;STA $C073
    STA    $304
    LDA    #$73
    STA    $305
    LDA    #$C0
    STA    $306
    LDA    #$6C           ;JMP ($300)
    STA    $307
    LDA    #$00
    STA    $308
    LDA    #$30
    STA    $309
```

## Available Banks

The following subroutine will find all valid banks, determine the size of RamWorks II memory, and save the results into BankTbl. BankTbl will have the number of 64K banks found, followed by the table of valid bank numbers. Keep in mind that the bank numbers are not necessarily linear.

For example: 'BankTbl:08 00 01 02 03 04 05 06 07' indicates a 512K RamWorks II containing banks 0 through 7.

```

BankSel    EQU        $C073

*Write bank number to each bank
          STA        $C009        ;Store in alternate zero page
          LDY        #$7F        ;Valid banks range $00 to $7F
FindBanks STY        BankSel      ;Go through each bank
          STY        $00        ;Store the bank number
          TYA
          EOR        #$FF
          STA        $01        ;Second self-check
          DEY
          BPL        FindBanks

*Read them back to find valid banks and save in table
          LDA        $00
          TAY
          TAX
FindThem  STY        BankSel      ;Search through all banks
          STA        BankSel+7
          CPY        $00
          BNE        NotOne      ;Check bank number
          TYA
          EOR        #$FF
          CMP        $01        ;Check second double-check
          BNE        NotOne
          INX
          TYA
          STA        BankTbl,X   ;Found valid bank-save in table
NotOne   INY
          BPL        FindThem
          LDA        #$00        ;Reset to video bank
          STA        BankSel
          STA        $C008
          STX        BankTbl     ;Size of Ram card
          LDA        #$FF
          STA        BankTbl+1,X ;Mark end of table
          JMP        Continue

BankTbl   DS         50        ;Enough banks for three meg.

```





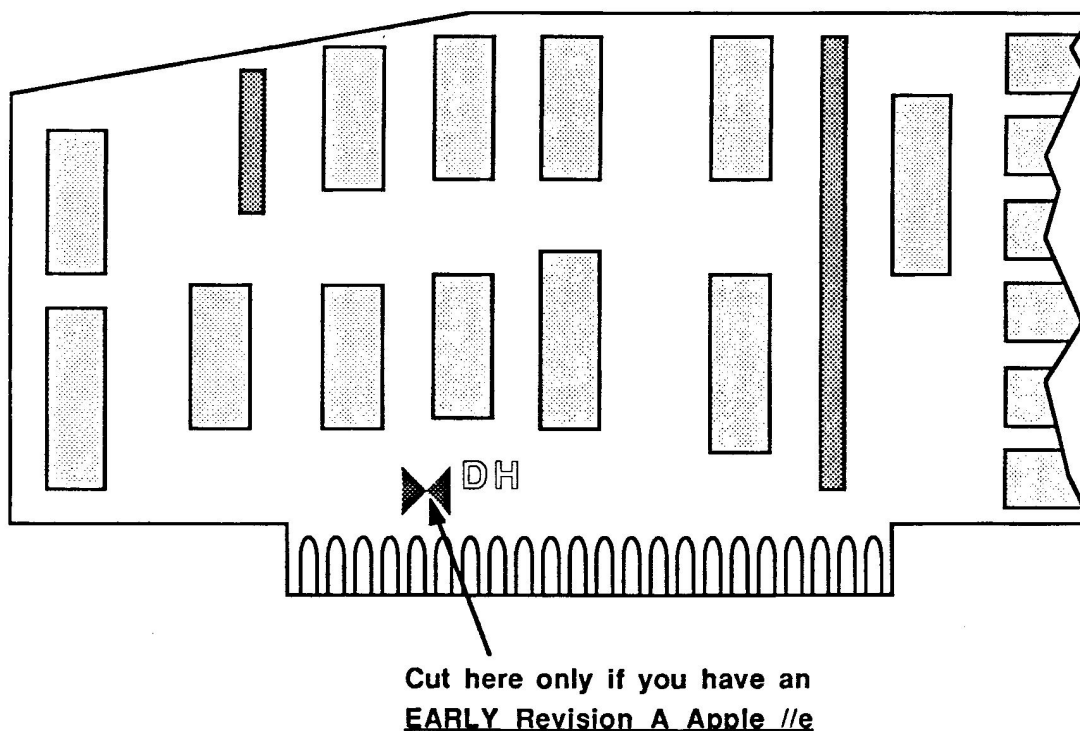
## Early "Revision A" Apple //e Computers

There are currently three revision levels of domestic (U.S.) Apple //e main logic boards (motherboards). The first, the "early Revision A board", was sold for a very short period during early 1983. This board had a part number of 820 - 0064 - A and it did not support double high resolution graphics. Shortly thereafter, Apple introduced part number 820 - 0064 - B (revision B) which did fully support double high-res graphics. The Enhanced //e, introduced in early 1985, has a redesigned main logic board with a new part number, 820 - 0087 - A, and, of course, does support double "hi-res". Illustration 2-1 on page 3 indicates the location of the part number.

**Important Note:** If you have an early "revision A" computer, contact your authorized Apple dealer about an upgrade to a later revision. He can provide you with information on Apple Computer's update policy for Rev. A owners who want double high resolution graphics.

If you do have the early "revision A" Apple //e, you can still use RamWorks II, but the Ramworks II card must be modified and consequently your computer will not support double high resolution graphics. In fact, the 820-0064-A motherboard will not work at all with an unmodified RamWorks II. The modification is simple; just cut the "solder switch" marked "DH" on the RamWorks II printed circuit card. This switch is located slightly above the gold edge connector on the component side of the board. It looks like a tiny bowtie. (See Illustration A-1.) Use an Exacto knife or sharp penknife to just break the connection where the two points join. Reconnecting this switch can be accomplished with a small blob of solder.

Illustration A-1 Double High Resolution Graphics Switch



### The RamWorks II Memory Test

The purpose of this test program is to verify the basic operation and hardware reliability of the RamWorks II card. If you encounter problems when running a program that you feel could be RamWorks II memory related this test is a good first step in diagnosing the problem.

**DO NOT** attempt to repair your computer unless you are sure of what you are doing!

To run this test program, turn the computer off, insert the "Super AppleWorks Desktop Expand" disk in your startup drive, and turn the computer on. When the main menu appears, select the "RamWorks Memory Test" option.

During the first part of the test you will see the screen partially fill with characters, followed by several lines of text. As the test continues, the screen will clear, followed by a display of the banks of memory found by the test program. In the upper right hand corner of the screen is a "pass indicator" which will show how many times the memory test has been performed. After eight passes the test ends and displays the results on the screen. The message "MEMORY TEST PASSED" indicates the RamWorks II card is functioning correctly.

You may run this program as many times as you wish. The amount of time required to complete this test depends on the amount of memory available on the RamWorks II and RamWorks Memory Expander cards.

If the test passes and you are still experiencing problems with your program, the next step would be to eliminate the software as a possible source of the problem. Try running different software packages or another copy of the program you are having problems with. Our experience has shown that a large majority of "program crashes" are not necessarily caused by hardware failures but by software problems. Many software publishers offer technical support for software related problems.

If the RamWorks Memory Test fails, turn the system off, insure that all of the socketed memory chips and connectors are correctly and securely seated. (Often, just reseating the chips and connectors has a magical healing effect on a sick computer!) Turn the system on and run the memory test again. If it still fails contact Applied Engineering Technical Support. Please provide the following information:

- Version number of Super AppleWorks Desktop Expander disk.
- Revision level/part number of Apple // e (See Appendix A).
- Revision level, original memory configuration, and the current memory configuration of your RamWorks II card.
- Software package and software revision level.

---

## RGB Color Option for RamWorks II

For those users who wish RGB color graphics and expanded memory, Applied Engineering offers the RGB option for the RamWorks II. This option is fully compatible with Apple's Extended 80 Column Color Card. Since virtually all //e software which supports RGB conforms to this standard, you are assured of the highest degree of software compatibility when using the Applied Engineering RGB option. The RGB option consists of a circuit board which plugs into the connectors on the solder side of the RamWorks II card and an interface cable which connects the output of the RGB card to the rear panel of the computer.

Hardware output of the RGB option interface card is true digital RGB and uses a standard 15 pin "D-shell" connector. Some manufacturers provide a special cables which interface their monitors and the standard connector.

Below is a list of RGB monitors that have been tested by Applied Engineering and are known to be compatible with the RGB option. Monitors indicated by an asterisk are recommended by Applied Engineering for their excellent color and sharp, clear image.

### Monitors Tested with RGB Option

RGB Monitor	Comments
Apple Color Monitor 100	Comes with cable and 15 pin connector
Amdek 500 Amdek 600 Amdek 700	Amdek monitors listed require a cable made by Amdek. Part number AC-1100.
Taxan 400 Taxan 410 Taxan 415 Taxan 420*	Taxan monitors require Taxan cable, part number 410-05.
Panasonic DTD 1300 Panasonic DTH 103*	Use Panasonic interface cable, part number ET101C.

This is only a partial list of compatible RGB monitors. There are many other high quality monitors available. We suggest you use this list only as a guide when shopping for your monitor.





