OPERATIONS
MANUAL

64K/128K RAM BOARD

SATURN
SYSTEMS

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REGISTRATION CARD:

Please fill out and return at your earliest convenience, the enclosed registration card. This will enable Saturn Systems to notify you concerning future updates and new software releases relating to the Saturn 64K and 128K RAM boards.

SERVICE:

If your Saturn RAM board should require service, please return it to the dealer from whom it was purchased, or send it postage paid directly to Saturn Systems, Inc. Be sure to include proof of purchase.

Ship to:	Saturn Systems, Inc. 3990 Varsity Drive Ann Arbor, MI 48104

Chapter 1

INTRODUCTION

The Saturn 64K and 128K Ram Boards are expansion plug–in cards designed to provide an extra 64K or 128K bytes of random access memory for Apple II and Apple II plus computers. To make use of the additional memory, Saturn Systems provides a package of applications software at no additional charge. The Saturn RAM boards and accompanying software require that the Apple be outfitted with a full 48K of main board RAM, as most Apples are today.

The 64K and 128K Ram boards are compatible with software designed to run with Apple's Language Card (PASCAL, FORTRAN, LISA ver 2, etc.) as well as Microsoft's RamCard and Z80 Softcard (CP/M, COBOL–80, FORTRAN–80, etc.). This compatibility is possible due to its unique organization. The boards consist of 16K banks of memory (4 banks for the 64K board, 8 banks for the 128K), accessed one at a time. In this sense, the Saturn 64K or 128K board can be thought of as several 16K Ram boards occupying the same slot. The first of these 16K banks is controlled through software in exactly the same manner as Apple's Language Card and other 16K memory cards. As a result, existing software designed to run with the 16K memory boards and Apple Language Card will operate on the Saturn 64K or 128K board without modification.

Using DOS 3.3, the version of BASIC not resident in ROM (Integer for an Apple II plus or Applesoft for an Apple II) will automatically be loaded into the first 1.6K of the Saturn RAM board upon boot. This enables easy access to either BASIC (via INT or FP). In this respect the Saturn 64K or 128K board appears as a 16K RAM board. However, in addition to this first bank of 16K, higher banks are available as well. The software provided with the 64K and 128K boards takes advantage of the additional memory, allowing you to:

1. Relocate DOS to free up user memory.

2. Emulate a disk drive under DOS, PASCAL, or CP/M.

3. Store arrays and subroutines from Applesoft or Integer Basic.

Chapter 2

INSTALLATION INSTRUCTIONS

I. RECOMMENDED LOCATION

The recommended location for the Saturn 64K or 128K RAM board depends upon whether an Apple Language card, 16K RAM card, or firmware card is already present in the system.

1. If a Language card or 16K board is in slot 0, install the Saturn 64K or 128K RAM board in any available slot.

2. If an Applesoft or Integer firmware card is already present in slot 0, remove it from the system or move it to another slot. Install the Saturn RAM board in slot 0.

3. If no card is present in slot 0, install the Saturn board in slot 0.

II. INSTALLATION

1. Turn off the power to the Apple (check the power light to insure that it is not on)

2. Remove the cover by pulling on the right and left rear corners of the case, until both fasteners are released (popping sound); slide the cover back until the front edge clears the lip of the case, and lift up.

3. Find the desired slot. Slot number designations are printed on the Apple's main circuit board along the back edge near the cutouts in the case. The leftmost slot is slot zero (closest to the power supply, which is a long metal box).

4. Before touching any component or board in the Apple, discharge any static charges, by touching the power supply cover (long metal box at left side of Apple) immediately prior to touching the component or card in the Apple.

5. Unpack the memory board. The memory board is packed in a bag made of specially treated antistatic material to prevent damage during shipment. It should be stored in this bag when not installed in the Apple, or if transported outside the Apple.

6. Install the board in the desired slot:

    A. Touch the power supply cover to discharge any static charges.

    B. Grasp the board at its edges and position over the slot.

C. Align the gold edge connector fingers with the slot of the socket, centering the card in the socket prior to insertion.

D. Apply gentle downward pressure with slight front to back rocking until the card seats fully.

7. Replace the cover by placing over opening, sliding forward until properly aligned, and applying pressure at the back until it snaps into place. Be careful not to apply pressure to the front of the Saturn RAM board as this may unseat the card.

III. **INSTALLING ADDITIONAL SATURN 64K and 128K RAM BOARDS**

The same procedure is followed for installation of multiple Saturn 64K or 128K RAM boards, as was used to install the first.

Chapter 3

USING THE SATURN 64K AND 128K BOARDS

Procedures for using the Saturn 64K and 128K RAM boards are described in this chapter, with particular emphasis being given to the operation of the card with APPLESOFT and INTEGER BASIC under DOS DOS 3.3.

As indicated in the introduction to this manual, the Saturn 64K and 128K RAM boards have been designed to be compatible with existing software which runs on Apple's Language card and other manufacturers 16K memory boards. Compatibility is maintained because the first bank of 16K on each of these cards is accessed in the same manner as the language card, and therefore appears as such to the software.

In most instances, the operation of the memory boards is transparent to the user, i.e., when the particular software system being used is booted, this software recognizes the first 16K of the memory board and uses it automatically.(Provided that the memory board is in slot 0.) Much of this software is only provided on 16 sector disk (DOS 3.3), for example Apple FORTRAN, PASCAL, CPM56 (for upgrading CP/M systems to take advantage of the memory board), and thus requires a 16 sector system (DOS 3.3) for operation. Where use of this software is required, upgrading to a 16 sector system is recommended.

Examples of software which will use this first 16K of the Saturn 64K and 128K RAM Boards, when in slot 0, are given below:

Personal Software's VisiCalc
Apple's PASCAL
Apple's FORTRAN
Integer BASIC
Applesoft BASIC
CP/M
Microsoft's FORTRAN—80
Microsoft's COBOL—80
etc.

For further details concerning booting these systems and operating them, consult the respective instruction manuals.

I. USE WITH APPLESOFT AND INTEGER BASIC

One of the features which is available with the Saturn 64K and 128K RAM Boards is the ability to have Applesoft or Integer BASIC present in the Ram Board and access these in a similar manner as one does using an Apple Firmware card (Integer card or Applesoft card).

A. APPLE II:

Since Apple II's are provided with Integer BASIC in ROM, Applesoft can be made available by loading it into the Saturn 64K and 128K RAM Board (first 16K bank of this card). When Applesoft is required, it can be accessed by typing FP. The portion of the first bank of the Saturn RAM Board containing Applesoft is then enabled, which brings APPLESOFT into the machine in place of the main board ROM Basic (INTEGER).

B. APPLE II PLUS:

Apple II plus' have Applesoft in ROM. Integer BASIC can be loaded into the Saturn 64K or 128K board and accessed later by typing INT. This results in enabling the portion of the RAM board which contains Integer, bringing it into the Apple in place of Applesoft. In either case, as far as this application is concerned, the Saturn RAM Board operates as either an Integer card (for Apple II Plus) or an Applesoft card (for Apple II).

For the above operation to occur,the Saturn card MUST be located in slot 0, and, as a result, an Integer or Applesoft card previously in slot 0 is no longer used, once the Saturn RAM Board has been located in this slot. There is no provision in the standard DOS 3.2 or 3.3 for accessing an Applesoft or Integer card which is located in a slot other than zero. However, this capability has been provided in the DOS relocation software (MOVEDOS) included with the Saturn 64K and 128K RAM Boards (see Chapter 4).

II. SATURN RAM BOARD OPERATION WITH DOS 3.3

DOS 3.3 is designed to take advantage of an Apple Language card, 16K memory card, or Apple Firmware card (INTEGER or APPLESOFT card). The HELLO program provided on the distribution copy of DOS 3.3 tests for the presence of an Integer or Applesoft card, or language card (16K memory card) in slot 0, and if the latter is present, loads the required language (Applesoft in an Apple II, or Integer in an Apple II Plus) from disk into the memory card. The distribution copy of DOS 3.3 contains copies of the ROM versions of both Applesoft and Integer BASIC, saved as binary files. Whenever DOS 3.3 is booted, this loading process is repeated, provided that the HELLO program as well as the required BASIC (binary file) is present on the particular disk being booted.

In this respect the Saturn 64K or 128K RAM board operates as a language card, and appears to DOS as such. If placed in slot 0, the required Basic will be automatically loaded upon boot, just as occurs with the Apple Language card, or other 16K memory boards.

Although the Saturn 64K and 128K boards will appear as a 16K RAM board to much existing software, allowing this software to take advantage of this portion of the memory board, its real utility lies in the ability to use the additional memory on the board. Five software packages are provided with the 64K and 128K RAM boards, which are designed specifically to utilize all of the memory on these boards. In fact, more than one board (as well as a variety of other RAM boards) may be used with this software. Any combination of the following, up to a total of 256K of external RAM, are supported.

1. Saturn 64K RAM Boards
2. Saturn 128K RAM Boards
3. Saturn 32K RAM Boards
4. Standard 16K RAM Boards

III. **SPECIAL TREATMENT FOR THE APPLE LANGUAGE CARD**

The Apple Language Card must be given special consideration. The reason for this is because it contains an Autostart ROM which is always enabled (on) whenever the RAM on the card is disabled. This results in a conflict when any other memory card is present in the system in addition to the language card. A special provision has been made in the MOVEDOS, RAMEXPAND and PASCAL PSEUDO—DISK software packages to accomodate this conflict.

What actually occurs in these cases is that the memory space occupied by the AUTO—START ROM ($F800 — $FFFF) is specifically avoided by the above software so that a memory conflict will never occur. Avoiding this space results in the inability to use 2K out of every 16K bank of every memory card in the system.

For example:

Memory Cards Present (exclusive of language card)	Available Memory with Apple Language Card present
1 Saturn 32K RAM (2 — 16K banks)	44K
1 Saturn 64K RAM (4 — 16K banks)	72K
1 Saturn 128K RAM (8 — 16K banks)	128K

Thus, when an Apple Language card is added to a system containing a 128K board, the increase in space (16K) is exactly matched by the space made unavailable on the 128K board (8 x 2K) due to the presence of the language card. As a result, no benefit is gained by having the language card in the system at this point.

The current versions of the DOS and CP/M pseudo—Disks (Chapters 6 and 8) DO NOT have the necessary special provisions so as to avoid this address conflict and therefore cannot be used in a system which contains the Apple Language Card in addition to other expansion RAM boards (Saturn 32K, 64K, 128K) Removal of the Apple Language Card is required for operation in these cases.

Support of the language card is expected in a future release of the CP/M and DOS Pseudo—Disks, which will be made available to Saturn RAM board users at minimal cost.

An alternate solution to the multi—board Language card memory conflict problem involves a hardware modification to the Apple Language card. This modification is described in the Dec. 1981 issue of Softalk Magazine (vol. 2), p. 184. This modification will result in the elimination of the ROM address conflict, so that the Language card can be used just like any other 16K RAM board, in as far as the software supplied with the Saturn 64K and 128K boards is concerned.

IV. **OVERVIEW OF SOFTWARE**

The following is a brief description of the software packages included with the Saturn ~4K and 128K RAM boards:

A. MOVEDOS (Chapter 4)

This program will relocate DOS 3.2 or 3.3 into the second 16K bank of the 64K or 128K RAM board, freeing up approximately 10K of memory. Integer or Applesoft Basic can be loaded into the RAM board and accessed from the card as well as *DOS.* This program is very useful in applications where memory is a limitation.

B. RAMEXPAND (Chapter 5)

This package consists of a set of utility subroutines accessible from Applesoft or Integer Basic which enable one to accomplish very rapid data transfer from program memory to the memory on expansion RAM boards (32K, 64K, and 128K boards). Arrays, subroutines, and parts of programs can be saved and loaded from the memory on the expansion boards very rapidly so as to maintain ready access to this information. This package will work in the relocated DOS environment as well as with a normal DOS.

C. DOS PSEUDO—DISK (Chapter 6)

This package allows you to use one or more Saturn RAM boards to emulate a standard disk drive. The software works with a normal DOS as well as a relocated DOS on Saturn 32K, 64K, and 128K RAM boards, and 16K boards.

D. PASCAL PSEUDO—DISK (Chapter 7)

This package allows you to emulate a disk drive under the PASCAL operating system. This results in increased throughput and faster system operation. Included are utilities for quickly moving files up onto the PSEUDO—DISK, etc.

E. CP/M PSEUDO—DISK (Chapter 8)

This package patches CP/M so that it can use the Saturn RAM board(s) as a fast disk drive.

Chapter 4

MOVEDOS DOS RELOCATION SOFTWARE

The software provided with the Saturn 64K and 128K boards enables one to take advantage of a portion of the RAM present on these cards by moving DOS (DOS 3.2 or 3.3) up into the board, thus freeing up approximately 10K of memory for user programs.

In a 48K system, DOS normally resides at the top of the 48K of RAM, occupying 10.5K of RAM (from $9~00 to $BFFF). HIMEM is set to reflect the presence of DOS (HIMEM = $9600). As long as DOS is resident, the memory occupied by it is not available for program use. The program MOVEDOS, provided with the Saturn 64K and 128K boards, frees up 10K of the memory space normally occupied by DOS, while at the same time keeping DOS in the system, and available. This is accomplished by relocating (moving) DOS up into the Saturn RAM board and making appropriate modifications to the system so as to be able to communicate with this relocated DOS. DOS is kept in the 64K or 128K memory board, and used when required.

Essentially DOS is stored in a portion of the Saturn 64K or 128K board which is disabled (turned off) until it is needed. As a result, when DOS is not being used, it isn't sitting in lower memory, taking up valuable space. When DOS is required, it is used in the following manner.

1. The part of the Saturn 64K or 128K board which contains DOS is enabled (turned on). This results in BASIC (Integer or Applesoft) being disabled (turned off) and no longer resident.* This poses no problem, since BASIC is not required by DOS during the time a DOS command is being executed.

2. The desired DOS command is executed by the relocated DOS, now resident in the system.

3. The portion of the Saturn RAM board which contains DOS is disabled (turned off) . The BASIC which had been present prior to the call to DOS is re—enabled, and control is returned to the program from which DOS was called.

In this way, as far as the user is concerned, DOS is present in the system and there is 10K more memory available for program use. In addition, the user has access to either BASIC (Integer or Applesoft), since either of these can be present in the Saturn

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* Note: This occurs because the relocated DOS actually shares the memory space occupied by BASIC. ($DOOO—$FFFF)

64K or 128K board as well as the relocated DOS. Also, through the use of the DOS PSEUDO—DISK, the rest of the RAM board may be used as a fast RAM—DISK, greatly improving disk access and overall system performance (see Chapter 6)

I. **FEATURES OF THE RELOCATED DOS**

All the features of normal DOS are retained in this relocated DOS, including the ability to initialize disks. When a disk is initialized, the relocated DOS is written to the disk from the Saturn 64K or 128K board. When this disk is later booted, the relocated DOS is brought into the RAM board properly, with everything set up to use it. Thus the program which does the actual relocation (MOVEDOS) only needs to be run once.

The capability of using an Integer or Applesoft card in a slot other than 0 has been added to this relocated DOS. This enables one to take advantage of one of these cards if present, as well as the Saturn RAM Board. Details of how to configure the system to take advantage of this are given later.

MOVEDOS has been designed to operate with a 54K or 128K RAM board in a slot other than 0, and properly relocate DOS into this slot. MOVEDOS actually searches for the first 64K or 128K card it finds starting at slot 0 and moving upward.

The language card and address conflict (see Chapter 3) has been accomodated for in a special version of the MOVEDOS program provided on the distribution diskette. This version of movedos (MOVEDOS.LANG) has been designed to avoid the upper 2K of address space on Saturn 64K or 128K RAM boards.

II. **USING MOVEDOS**

The software provided with the Saturn 64K or 128K RAM Board is distributed on a 16—sector disk. It can be used directly with DOS 3.3, however it is recommended that a back—up be made as soon as possible. When using the software with DOS 3.2 it is suggested that the programs be converted to 16 sector format using a program such as DEMUFFIN prior to use. Again, a backup should be maintained.

In order to relocate DOS, the program MOVEDOS is used. This program moves the existing copy of DOS (3.3 or 3.2) resident at the top of the 48K of user memory ($9600—$BFFF) into the second 16K bank of the Saturn 64K or 128K board and makes appropriate changes to enable communication with this relocated DOS, in place of the normal DOS. As stated previously, MOVEDOS does not require that the Saturn RAM Board be present in slot fl, however this positioning is recommended so that other software such as PASCAL, VisiCalc, etc., will be able to find it.

A. Running MOVEDOS with DOS 3.2

1. Boot a standard DOS 3.2 system.

2. Run the DEMUFFIN or similar program to convert the file MOVEDOS to 13 sector format.

3. Run MOVEDOS by typing BRUN MOVEDOS. The system will respond by displaying a message indicating that DOS is being loaded into the RAM board, the relocation will take place, and control will return to BASIC.

4. A blank disk can be initialized in the normal manner, if desired, resulting in a copy of the relocated DOS which can later be booted, as with any disk that has been initialized. It is recommended that any disks initialized with the relocated DOS be labeled as such, to prevent possible confusion with normal DOS initialized disks.

5. Integer BASIC (Apple II plus) or Applesoft (Apple II) can be loaded into the first 16K bank of the Saturn 64K or 128 K board as described previously (chapter 3, part III) using a HELLO program, if desired.

B. Running MOVEDOS with DOS 3.3

1. Boot a standard DOS 3.3 system.

2. Insert a 16—sector disk containing a copy of the MOVEDOS program (or the master itself — CAUTION!) and type BRUN MOVEDOS. The system will respond by displaying a message indicating that DOS is being loaded into the RAM board, the relocation will take place, and control will return to BASIC.

3. A blank disk can be initialized with a copy of the relocated DOS which can be later booted, if desired, by following normal initialization procedures. It is recommended however, that any disks initialized with the relocated DOS be labeled as such to avoid possible confusion with normal DOS initialized disks.

4. Integer BASIC (for an Apple II plus) or Applesoft (for an Apple II) can be loaded into the first 16K bank of the Saturn board (unused by the relocated DOS) by running the standard HELLO program provided on the distribution copy of DOS 3.3.

C. Running MOVEDOS on a system containing an Apple Language Card

If an Apple Language Card is being used, a special version of MOVEDOS must be used. This is provided on the distribution disk as MOVEDOS.LANG. The previous discussion regarding the running of MOVEDOS also applies to MOVEDOS.LANG (sections A & B; above).

III. **<u>USING</u> AN <u>APPLESOFT</u> <u>OR</u> <u>INTEGER</u> <u>CARD</u>**

As indicated previously, a provision has been made in the relocated DOS to enable the use of an Apple Firmware card (Integer card or Applesoft card) from a slot other than 0. The relocated DOS is set up (as default) to look for the alternate BASIC (Applesoft in an Apple II and Integer in an Apple II plus) in the slot which contains the Saturn 64K or 128K RAM board. It actually looks at the first 16K bank of the board for the presence of the desired BASIC (the second 16K bank of this board contains the relocated DOS).

This default can be easily changed using one of the configuration programs provided with the Saturn 64K or 128K board, so that a different slot will be used for BASIC. One can then place the desired Apple Firmware card in this slot (Applesoft card for an Apple II; IntegEr card for an Apple II plus) and gain access to it.

The following is a step by step procedure for making this change.

1. Do one of the following:

   a) Boot a standard DOS (3.2 or 3.3) and run MOVEDOS

   b) Boot a relocated DOS from a previously initialized disk.

2. Run the appropriate configuration program:

   a) RUN SET INTEGER SLOT ——— on an Apple IT plus

b) RUN SET APPLESOFT SLOT — on an Apple II

3. Enter the slot number containing the firmware card (Integer or Applesoft card) when prompted. The program will make the required changes to the relocated DOS currently resident so as to use this card.

4. The relocated DOS with configuration intact can be saved at this point for future use by initializing a disk with this DOS.

NOTE: The HELLO program used with this modified DOS should he changed so that it does not test for the presence of a language card in slot 0, anc load Basic. Otherwise a copy of this Basic will be loaded into the first half of the RAM card in slot 0, as well as being present on the firmware card, from which it will be accessed when requested (by typing FP on an Apple II and INT on

Apple II Plus).

PRECAUTIONS CONCERNING BOOTING DISKS:

This precaution applies to systems which have been configured (using the configuration program) to use an Integer or Applesoft firmware card with the relocated DOS. In this situation, it is recommended that booting (via PR#6, etc.) be accomplished from the main board ROM BASIC (i.e. Applesoft in an Apple II plus; Integer [or monitor] in an Apple II), and not from the BASIC present in the Apple Firmware card. This is to insure that the firmware card is not left on after the boot.

The relocated DOS has been designed to operate properly with an Applesoft or Integer card during the boot process, and can therefore be booted from either Integer or Applesoft. However, the standard DOS 3.3 or 3.2 (such as that present on the system master) does not have a provision for use of an Integer or Applesoft card from a slot other than 0, with the relocated DOS. If the precaution is not taken to return to the main board ROM BASIC prior to the boot in this case, the firmware card will be left on after the boot with no way for DOS to turn it off, and the system will hang.

In summary:

When operating under the relocated DOS with an Integer or Applesoft card in a slot other than 0,

1. Boot a relocated DOS as usual, either from Applesoft or integer

2. Boot a standard DOS only from the main board ROM BASIC,

   a) Integer (or monitor] on an Apple II.
   b) Applesoft on an Apple II plus.

IV. **<u>COMPATIBILITY</u> OF <u>RELOCATED</u> <u>DOS</u> <u>WITH</u> <u>EXISTING</u> <u>SOFTWARE</u>**

In many respects the relocated DOS can be treated just as a normal DOS 3.2 or 3.3. In some instances however, problems arise where a particular application program attempts to make internal modifications to DOS. Such programs may not operate properly since DOS is no longer located where it is expected by the program (i.e. at the top of the 48K of RAM). In these instances a modification of the particular program involved may be required to permit operation with the relocated DOS.

A. MODIFICATION OF FID AND MUFFIN

Two programs provided on the DOS 3.3 system master, FID and MUFFIN contain a minor bug which arises when an attempt is made to run these programs with the relocated DOS. The program called MOD, included in the software package with the Saturn 64K and 128K boards will repair this bug so that both FID and MUFFIN will run with the relocated DOS as well as the normal DOS.

In addition to modifying FID for use with the relocated DOS, MOD will also make necessary changes to FID so that it can be used with the DOS PSEUDO—DISK (see Chapter 6). The modified FID can be used as a direct replacement for FID (as distributed on the DOS 3.3 system master), with or without the PSEUDO—DISK, or the relocated DOS.

B. MODIFICATION OF BOOTl3

Modification of the program BOOTl3, provided on the DOS 3.3 system master, is required for proper operation with DOS 3.2 disks initialized under the relocated DOS. MOD will make the required changes to BOOTl3 to allow use with the relocated DOS.

V. **TECHNICAL INFORMATION**

A. RELOCATED DOS OPERATION

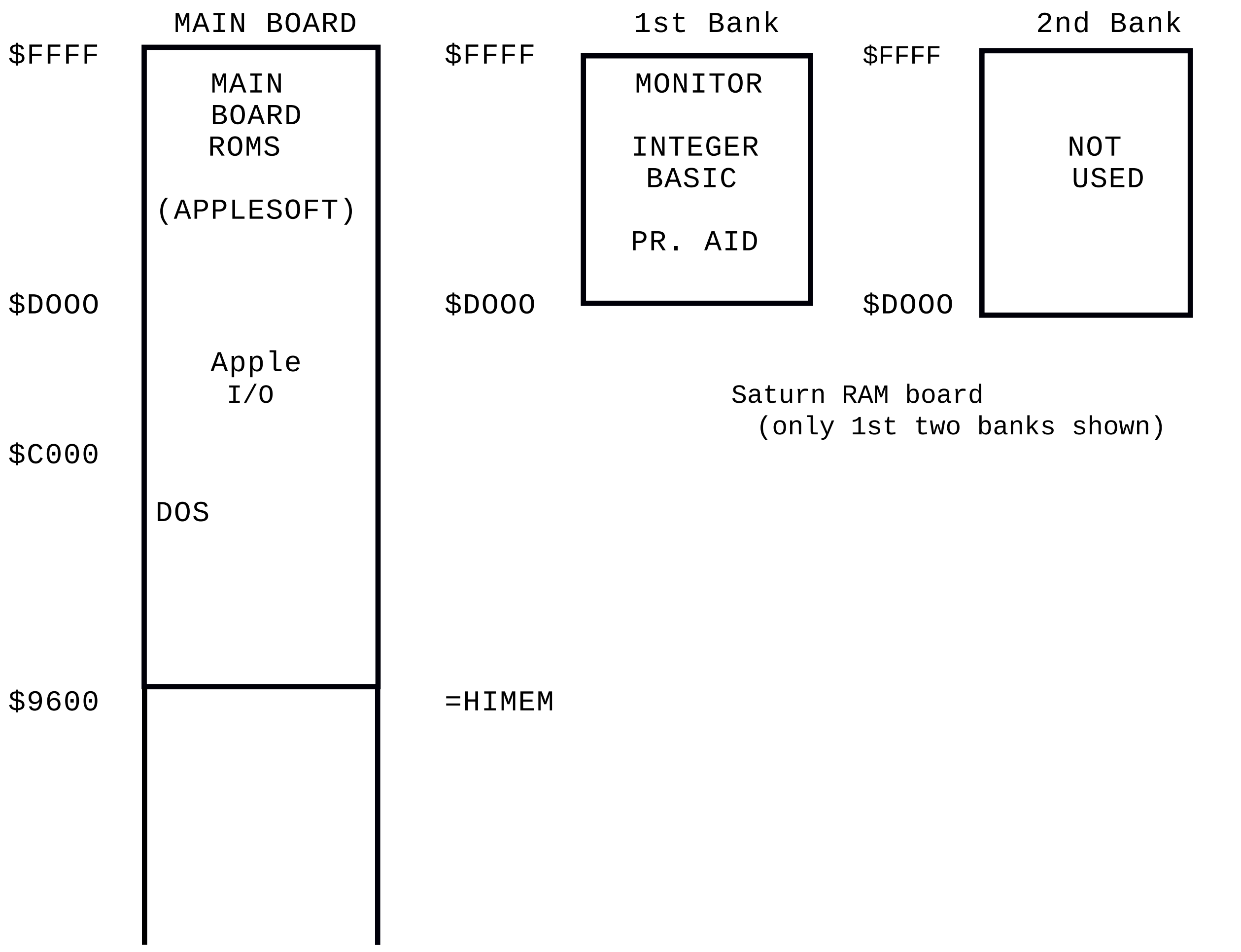
As described previously, the program called MOVEDOS does exactly what its name implies; it moves the existing DOS (ver 3.2 or 3.3) present at the top of the 48K of user RAM ($9~OO—$BFFF) into the Saturn 64K or 128K board. In addition to being able to maintain DOS in the RAM board, the alternate BASIC may reside there as well (Integer BASIC on an Apple II plus, Applesoft on an Apple II). This is possible because DOS is moved (by MOVEDOS) into the second 16K bank of the RAM card (not used by BASIC). All but 4K of this 16K bank is used by the relocated DOS and associated monitor routines. The unused 4K portion of the second 16K bank of the Saturn board will be used by future software packages supporting the 64K and 128K RAM boards.

Now, when a DOS command is invoked from Applesoft, Integer BASIC, a machine language routine or the keyboard, it is executed by the relocated DOS present in the Saturn RAM board. A small portion of DOS is maintained within the lower 48K of RAM from $BEOO to $BFFF. This part of DOS includes a short routine which serves to enable (turn on) the required part of the Saturn 64K or 128K board which contains most of DOS, when DOS is called. The DOS command is then executed by the relocated DOS in the RAM board, after which time this part of the Saturn RAM board is disabled, and the s/stem is returned to the state it was in prior to the call to DOS. The routines which enable the second bank of the Saturn 64K and 128K boards (containing DOS), as well as disable it when through, are located at the top of the user RAM from $BEOO to $BFFF, occupying 1/2 K. HIMEM is set to reflect this.

B. MEMORY USAGE

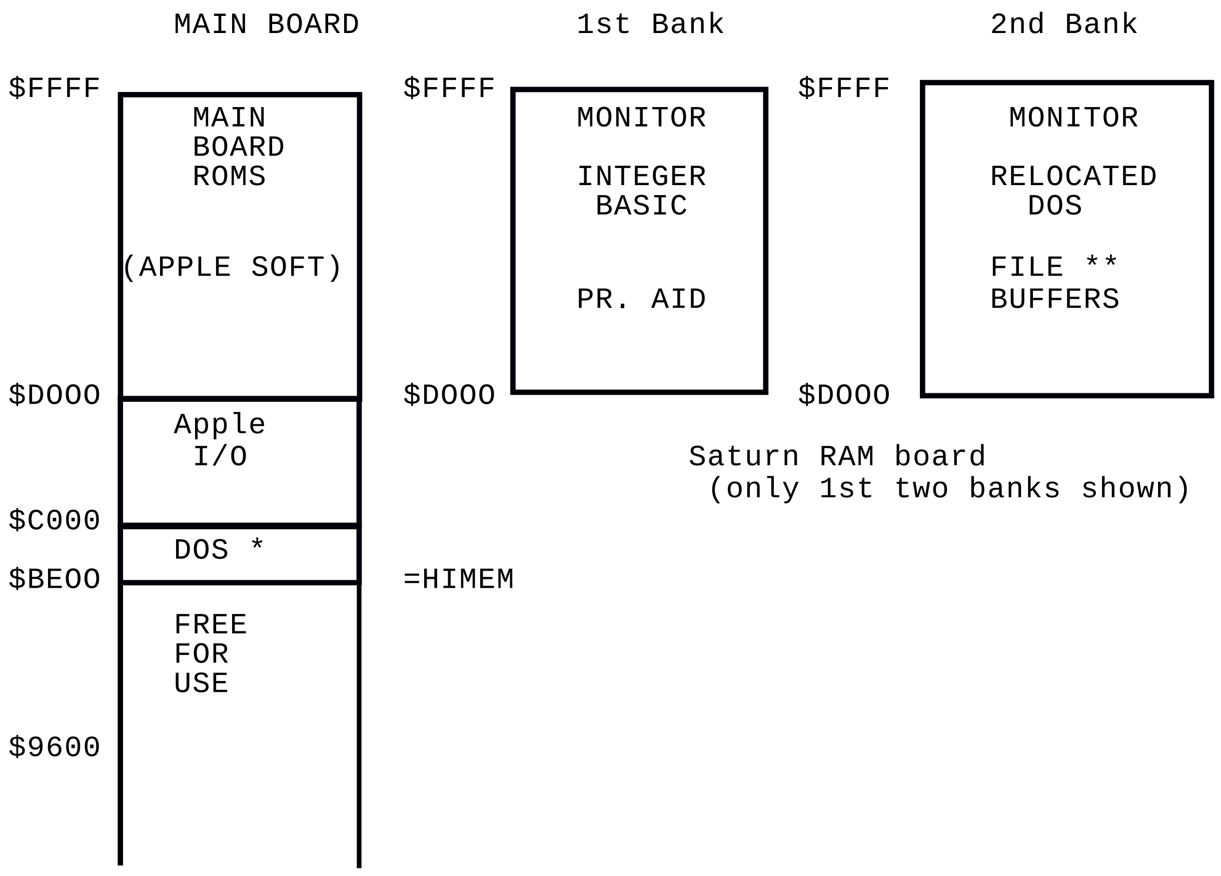
The memory maps presented on the following two pages illustrate how the system is organized with the relocated DOS present in the Saturn 64K or 128K RAM board, as compared to the standard DOS memory configuration. For sake of simplicity, the configuration applies to an Apple II plus (Applesoft in ROM). For Apple II configuration, exchange the contents of main board ROMS with that of the first bank of the Saturn RAM board, in each diagram.

The following memory map describes an Apple II plus with a standard DOS present as well as INTEGER BASIC in the RAM board. The 2nd 16K bank of this board is unused in this memory configuration. For clarity, the additional 4K banks (unused) are not shown (see Chapter for more details concerninq these 4K banks).



STANDARD DOS CONFIGURATION WITH INTEGER PRESENT IN RAM BOARD
{APPLE II PLUS]

After running MOVEDOS (or booting the relocated DOS), the following memory map describes the same system (Apple II plus, 48K, INTEGER present in RAM board). Again, the additional 4K banks are not shown in the figure.



RELOCATED DOS CONFIGURATION WITH INTEGER PRESENT IN RAM BOARD
[APPLE II PLUS]

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* The routines in this location ($BEOO-$BFFF) serve to enable the portion of the Saturn RAM board which contains the relocated DOS and set pointers for operation with this DOS.

** With MAXFILES = 3, all of DOS, including the file buffers fits in the second bank of the ram board. If MAXFILES is increased beyond 3, then the memory space below $BEOO is used, starting at this location, in increments of 595 bytes for the additional file buffers required. HIMEM is adjusted to reflect this.

C. MORE DETAILS CONCERNING MOVEDOS

When MOVEDOS is executed, the following occurs:

1. A search is made starting at slot 0, and incrementing upward, for a Saturn 64K or 128K board. if it is not found, the program halts with an appropriate message.

2. The version of DOS present in RAM is determined (DOS 3.2 or 3.3) and the appropriate modifications are made to allow it to run (when relocated) up in the RAM board. The boot routine is modified to allow loading of DOS from disk directly into the memory card. INIT is also changed to enable initialization with the relocated DOS.

3. The modified DOS is then loaded into the Saturn 54K or 128K RAM board.

4. The necessary routines which allow communication with the relocated DOS are put up at the top of the user RAM space (occupying 1/2K from $BEOO to $8FFF), and HIMEM is set to $BEOO.

5. The pointers in page 3 are changed indicating the new entry points to DOS.

D. MISCELLANEOUS ROUTINES, POINTERS, ETC.

Location	Function
$BFOO	Routine which enables the 16K bank of Saturn 64K or 128K board which contains DOS (called prior to entering relocated DOS) This routine also disables card containing alternate BASIC.
$BF17	Routine which disables 16K bank of Saturn 64K or 128K board which contains DOS. (called upon exit from relocated DOS) This routine also enables the alternate BASIC, if required.
$BF72, $BF73	BLOAD/BRUN start address (formerly at $AA72, $AA73)
$BF6O, $BF6l	BLOAD/BRUN length (formerly at $AA6O, $AA6l)
$BF66 – $BF73	DOS command parameter buffer (formerly at $AA66 – $AA73)
$BFB8	DOS I/O paramter area (formerly $B5BB)
$BFE8	DOS I/O block for RWTS (formerly $B7E8)

$4C, $4D (INTEGER) HIMEM = $BEOO (formerly $9600)
$73, $74 (APPLESOFT)

$3D0	Routine to re–connect DOS = $BF28 (formerly at $9DBF).
$BEE4 – $BEE8	Routine which effectively wipes out BASIC in Saturn 64K or 128K board upon boot of relocated DOS (slot 0 only) by writing 0 at location $EOOO. Change to NOP’s to defeat this feature.

Chapter 5

RAMEXPAND

RAMEXPAND is a software package consisting of a set of functions for extending the amount of RAM available to Applesoft and Integer programs. RAMEXPAND will use the memory on one or more Saturn 32K, 64K or 128K RAM Boards as well as that on any 16K board present in the system. Information in the form of data and programs or subroutines can be saved on these extension RAM boards for later retrieval. RAMEXPAND allows one to save complete programs which can later be loaded and run, overlay and chain subroutines and program segments, or save and recall arrays.

Flexibility has been incorporated into RAMEXPAND to allow portions of the memory board(s) (Saturn 32K, 64K, 128K RAM Boards, 16K board) to be reserved for such things as the alternate BASIC (Applesoft in Apple II, Integer in Apple II Plus). This memory can be reclaimed for use by RAMEXPAND at any time it is desired.

I. **CHARACTERISTICS OF RAMEXPAND**

A. TERMINOLOGY

Throughout this chapter, the term “extended RAM” will be used to describe the total memory present in the system contained on expansion RAM boards (Saturn 32K, 64K, 128K RAM Board(s), 16K expansion RAM board(s)). It should be noted that it is NOT necessary to have a 16K RAM board for any of the software provided by Saturn Systems; however, our software will take advantage of any 16K card which you may have purchased prior to the introduction of the Saturn RAM Board(s).

B. REQUIREMENTS AND MEMORY USAGE

RAMEXPAND occupies two portions of memory. Most of the RAMEXPAND system is located in the Saturn 32K, 64K, or 128K board which contains the relocated DOS and occupies the unused 4K bank within the second 16K bank of the board (bank which contains the relocated DOS). This is 4K bank 2B (see Technical Information section, Chapter 9). One page of memory from $BDOO to $BDFF (just below the interface routines to the relocated DOS) is also used by RAMEXPAND and HIMEM is set to protect this portion.

The RAMEXPAND system consists of three files, RAMEXPAND, RAMEXPAND.LOW, and RAMEXPA.LOAD. The program RAMEXPA.LOAD serves to load the RAMEXPAND system into memory and set various poin—

ters. The file RAMEXPAND is the portion of the system which resides in the Saturn RAM board. RAMEXPAND.LOW is the portion which resides in low RAM (normally at HIMEM). This low RAM portion of RAMEXPAND can actually be loaded and executed anywhere in low RAM (0 — 48K), although it is normally located at HIMEM, with HIMEM being lowered to protect it.

C. DATA STRUCTURE

RAMEXPAND saves and recalls selected parts of program text or data. Each portion is saved in an independent area in extended RAM. These areas are called segments. Each segment can contain a program, a part of a program, or the contents of an array. When information is saved in a segment, it must be given a name. When the information is retrieved, it is identified with this name. The “names” are in fact integers, and can be specified as variables which contain the segment names when calling RAMEXPAND, if desired. Segment names may be integers between 1 and 32,767. Zero, negative numbers, or numbers greater than 32,767 are illegal segment names.

D. MEMORY ALLOCATION

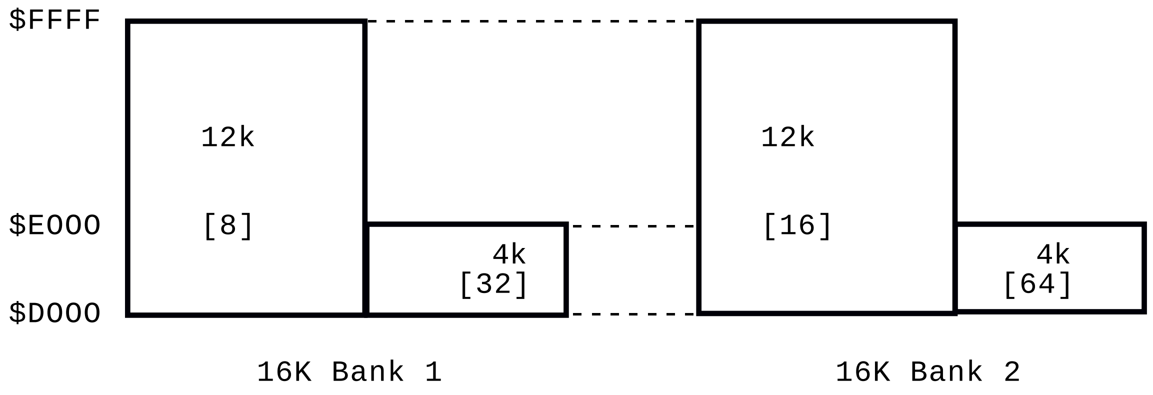
RAMEXPAND uses areas of the memory indicated as being available on one or more Saturn 32K, 64K, or 128K RAM Boards as well as on a 16K RAM board. RAMEXPAND treats each 16K bank of a given memory card as consisting of two blocks of memory, one which is 12K in size, and the other 4K. Thus a Saturn 32K board consists of 4 blocks, two 12K blocks and two 4K blocks, a 64K card consists of 8 blocks, and a 128K card consists of 16 blocks. On the other hand, a 16K board contains only 2 blocks, one 12K and one 4K.

Specific numbers have been assigned to these blocks and are used for specifying a particular block. Numbers are used to identify the blocks to be used by RAMEXPAND when the system is initialized.

The RAM boards can be divided into two groups based on the block designation numbers. The first group consists of 16K RAM boards and the Saturn 32K RAM board, and the second group, the Saturn 64K and 128K boards.

1. **SATURN 32K RAM Board and 16K RAM Board**

The memory organization of a Saturn 32K RAM board is given in the following figure. The particular number used to designate the depicted block is shown in brackets.



The following table gives the relationship between RAMEXPAND block designations and the bank designations established in the Technical Information Chapter of the Saturn 32K RAM board manual.

16K bank	Size	RAMEXPAND DESIGNATION	
1	12K	8	4K Bank lA + memory in region $EOOO – $FFFF
1	4K	32	4K Bank lB
2	12K	16	4K Bank 2A + memory in region $EOOO – $FFFF
2	4K	64	4K Bank 2B

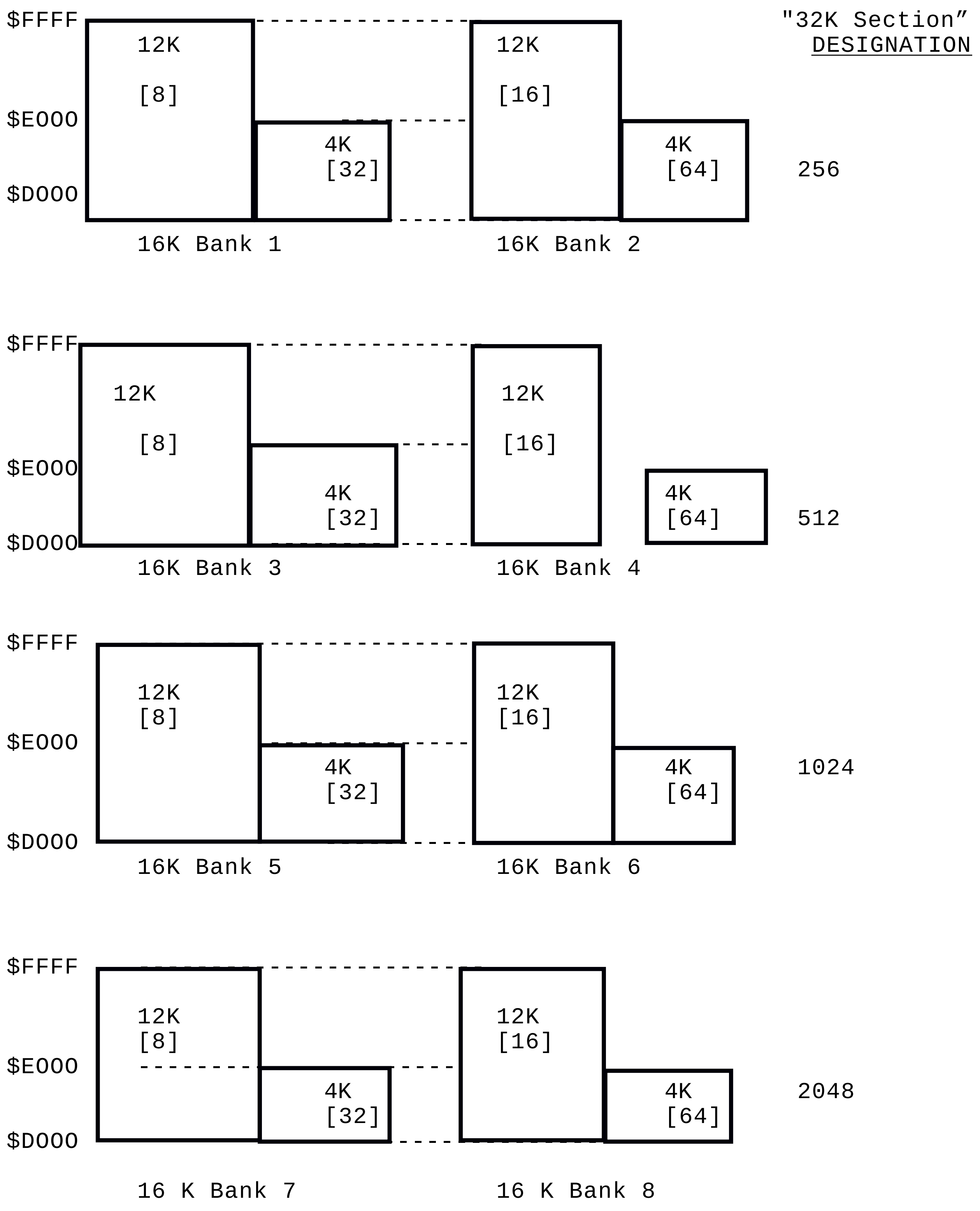
The RAMEXPAND block designations for a 15K RAM board correspond to those which are used to describe the first l6K bank in the above figure. Thus,

12K block = RAMEXPAND block designation 8
4K block = RAMEXPAND block designation 32

2. SATURN 64K and 128K RAM Boards

The Saturn 128K RAM board can be thought of as consisting of four 32K RAM boards (or sections), whereas the 64K board can be described in terms of two 32K sections. The block designation numbers for each bank within these 32K sections is the same as given above for the Saturn 32K board. Thus the designation numbers for the 12K blocks within the “32K sections” are 8 and 16, and the 4K blocks are 32 and 64.

In addition to this block specification number, the particular “32K section” which contains the desired block must also be specified. These are indicated using the “32K section” designation numbers given in the following figure.


"32K Section" DESIGNATION
$FFFF
$E000
$D000
12K [8]
4K [32]
16K Bank 1
12K [16]
4K [64]
16K Bank 2
256
$FFFF
$E000
$D000
12K [8]
4K [32]
16K Bank 3
12K [16]
4K [64]
16K Bank 4
512
$FFFF
$E000
$D000
12K [8]
4K [32]
16K Bank 5
12K [16]
4K [64]
16K Bank 6
1024
$FFFF
$E000
$D000
12K [8]
4K [32]
16 K Bank 7
12K [16]
4K [64]
16 K Bank 8
2048

Thus, in order to specify a given block of memory in a 64K or 128K board, the block designation number (8, 16, 32 or 64) must be provided as well as the designation assigned to the particular “32K section” of the board (256 = 1st 32K section, 512 = 2nd 32K section, 1024 3rd 32K section, 2048 4th 32K section). Refer to section II.E for the actual procedure used to tell RAMEXPAND which memory block to use.

E. SPECIAL REQUIREMENT IF LANGUAGE CARD IS PRESENT

The Apple Language Card requires special treatment for use with RAMEXPAND. This is due to the presence of the Autostart ROM on the Language Card (see Chapter 3, section III). The memory allocation for RAMEXPAND has been modified slightly in order to accomodate the language card. The RAMEXPAND block specification numbers remain the same, with the only difference being that the top 2K of each 12K block is not used by the RAMEXPAND system. As a result the blocks corresponding to the numbers 8 and 16 are 10K in size rather than 12K, when an Apple Language Card is used.

RAMEXPAND is told that a language card is present at the initialization and installation step, when the system is being set up.

II. **USE OF RAMEXPAND**

A. INSTALLING RAMEXPAND

The following procedure describes the steps which must be taken in order to install RAMEXPAND in the system.

2. First load RAMEXPAND by running the loading program:

RAMEX PA. LOAD

This program loads the two portions of the RAMEXPAND system (the portion which resides in the Saturn 64K and l2~?K RAM Board as well as the “low” RAM portion residing at $BDOO to $BDFF). It then sets HIMEM to protect the “low” RAM portion and sets up locations 10 — 12 to point to the entry point of RAMEXPAND. Thus RAMEXPAND can be called by simply using a CALL 10 or the USR function (Applesoft).

When run, RAMEXPA.LOAD will ask for the slot into which RAMEXPAND is to be loaded.

```
ENTER SLOT TO LOAD RAMEXPAND INTO:
```

Respond by entering the slot number containing the memory card (32K, 64K or 128K RAM board) into which RAMEXPAND is to be loaded

```
ENTER TYPE OF CARD YOU ARE LOADING

1=  128K (or 64K)
2=  32K
3=  128K (or 64K) , Language card present
4=  32K, Language card present
```

Responses:

1. Enter 1 if RAMEXPAND is being loaded into a Saturn 128K or 64K card and an Apple Language card is not present in the system.

2. Enter 2 if RAMEXPAND is being loaded into a Saturn 32K card and no Apple Language card is present in the system.

3. Enter 3 if the system contains an Apple Language card and RAMEXPAND is to be loaded into a Saturn 128K or 64K board.

4. Enter 4 if an Apple Language card is present in the system and RAMEXPAND is to be loaded into a Saturn 32K board.

RAMEXPAND is now installed in the system and ready for use. Two initialization and set—up procedures are generally required prior to actually moving programs and data into extended RAM by using the appropriate RAMEXPAND functions.

Before discussing these initialization procedures, the method of calling and communicating with RAMEXPAND will be desc-ribed.

B. COMMAND SET-UP

Prior to calling RAMEXPAND, a command must be set up. This command tells RAMEXPAND what function is to be performed as well as any necessary parameters. The command must be placed in the string CM$. RAMEXPAND will always look at CM$ for its command when called.

The command should contain 5 values, separated by commas. Each value may be a number or the name of a variable. In several cases the value must be a variable name. A sample command is as follows:

```
CM$ = “A,B,C,D,E”
```

In general the values represent the following:

A. FUNCTION. The first value identifies the function to be performed. This must be an integer in the range 0 to 14.

B. SEGMENT NAME. The second value gives the name of the RAM segment to use. (values: integer 1 — 32,767)

C. ERROR STATUS. The third value must be a variable name. RAMEXPAND will store a status value in the variable upon comp- letion of the function. This can be used to determine if the function was performed successfully.

D. START. The fourth value depends upon the particular function. It may represent the start of a program area, or an array name.

E. END. The fifth value also depends upon the particular function. It may represent the end of a program area.

C. CALLING RAMEXPAND

RAMEXPAND is called from BASIC programs using the CALL statement. Since locations 10 — 12 ($A — $C) are set to point to RAMEXPAND, a CALL 10 statement and in Applesoft the USR function both serve to call RAMEXPAND.

Thus, in summary, in order to execute a RAMEXPAND command, the command string CM$ is first set up, and then RAMEXPAND is called through a CALL 10, etc. This process is repeated for each command to be executed.

0. INITIALIZING RAMEXPAND

After RAMEXPAND has been installed (see previous section, INSTALLING RAMEXPAND), it must be initialized. This is accomplished through the RAMEXPAND initialization function (function code = 14). The command string to initialize RAMEXPAND is as follows:

CM$ = “14,0,A,0,0”

where A = error status variable.

E. ATTACHING MEMORY BLOCKS

Following initialization, the extended RAM memory to be used by RANlEXPAND should be specified. The connect function (#9) is used to attach blocks of memory to the system by indicating to RAMEXPAND which blocks of memory are to be used in a particular expansion RAM board (Saturn 32K, 64K, 128 RAM Board or 16K RAM board). This function can be used to “attach” a single block of memory or multiple blocks of memory within a given expansion memory board.

1. Saturn 32K and standard 16K RAM boards:

The following procedure is used for attaching blocks of memory on a Saturn 32K board, or a 16K RAM card.

To attach a single block to RAMEXPAND, the chosen block and slot number containing the memory card are stipulated as follows:

a) A block selection parameter is calculated by adding the slot # of the memory card to the block designation # (given in section I.D.l). For example, the block selection parameter of the first 12K block of a Saturn 32K RAM board in slot 2 is 2 [slot #3 + 8 [block designation #] = 10.

b) This block selection parameter is supplied as the second parameter in CM$ when the connect function (#9) is executed. Thus in above example, CM$ = “9,lO,A,O,O” where A= error status variable.

Additional calls to RAMEXPAND may be used to connect other blocks of memory as desired. More than one block within a given memory card can be attached with a single call to RAMEXPAND, by merely adding the corresponding block numbers along with the slot# to generate the block selection parameter. Thus, to specify the first and second 12K block of a Saturn 32K board in slot #2, the block selection parameter is:

```
    2   +  8   +   16    =    26
    |      |       |          |
  slot#   12K     12K       block
         block   block    selection
                          parameter
```

and CM$ = “9,26,A,0,0”.

2. Saturn 64K and 128K RAM boards:

The following procedure is used for attaching blocks of memory on a Saturn 64k or 128K RAM board to RAMEXPAND.

To attach a single block to RAMEXPAND, the chosen block and slot number containing the memory card are stipulated as follows:

a) A block selection parameter is calculated by adding the slot # +128 to the block designation # and the “32K section” designation given in I.D.2. Thus, for example, the block selection parameter of the 1st 12K block of a Saturn 64K (or 128K) board in slot 2 is calculated:

2 [slot #] + **128** [to indicate that this is a 54K or 128K board] + **8** F 12K block designation #1 + **256** [1st “32K section” designation #] = **394.**

b) This block selection parameter is supplied as the second parameter in CM$ when the connect function (#9) is executed. Thus in the above example, CM$ “9,394,A,0,0”, where A = error status variable

Additional calls to RAMEXPAND (function #9) may be used to connect other blocks of memory as desired. More than one block within in a given memory card can be attached with a single call to RAMEXPAND, by adding the corresponding block numbers, “32K section” designation numbers along with the slot # +l28 to generate the block selection parameter. Thus, to specify the first and second 12K blocks of a Saturn 128K RAM board in slot #2, the block selection parameter is:

```
      2  +  128  +  8  +   16  +  256  =   410
      |             |       |      |        |
    slot#          12K    12K     1st     block
                  block  block    32K   selection
                                section parameter
```

and CM$ + “9,410,A,0,0”

As a second example, to specify the first four 12K blocks of a Saturn 128K board in slot #2, the block selection parameter is:

```
  2  +  128  +  8  +  16  +  256  +  512   =    922
  |             |     |       |       |          |
slot#          12K   12K     1st     2nd       block
              block block    32k     32K     selection
                           section section   parameter
```

and *CM$* = **“9,922,A,0,0”**

When the connect function (#9) is executed, these blocks will be attached to RAMEXPAND. Additional connect function calls to RAMEXPAND should be executed for each expansion memory board to be used by RAMEXPAND. Some of the more common block selection parameter values are given in section VIII, under the subsection describing the “connect” function (#9) syntax.

F. RESERVING SPACE FOR BASIC

Space in a Saturn 32K, 64K or 128K RAM Board can be reserved for the alternate BASIC (Integer BASIC in Apple TI Plus; by not attaching the first 12K block (block designation #8) of the Saturn RAM board. The 4K block (designation #32) may be used for storage by RAMEXPAND without disturbing BASIC in the 12K block.

G. USING A FIRMWARE CARD

If An Apple Firmware card is present in the system, the RAMEXPAND system can be accessed from it as well. This is accomplished by first configuring the relocated DOS to access the language in the firmware card (see Chapter 4). Operation in this manner will enable one to gain maximum benefit of the extended RAM from both Applesoft and Integer BASIC.

III. **PRECAUTIONS**

A. PROTECTING RAMEXPAND

Since RAMEXPAND occupies the block with designation number 64, this block should not be specified for use by RAMEXPAND. If the relocated DOS is being used, the block containing it should also not be specified (#16).

B. SETTING MAXFILES

Once the low RAM portion of RAMEXPAND (RAMEXPAND.LOW) has been installed, it cannot be moved. As a result, MAXFILES must not be increased after RAMEXPAND has been installed. What should be done is to declare the largest value of MAXFILES required prior to running RAMEXPA.LOAD.

C. RELOADING RAMEXPAND

Everytime RAMEXPA.LOAD is run, the low RAM portion of RAMEXPAND is loaded and MAXFILES is lowered to protect it. By simply re—running this program, HIMEM will continue to be lowered. To prevent this from happening, execute a MAXFILES command to reset HIMEM before re—loading RAMEXPAND.

D. SWITCHING BETWEEN BASICS (FP OR INT)

Whenever FP or INT is executed (used when switching BASICS, etc), HIMEM must be declared so as to protect the low RAM portion of RAMEXPAND. If this is not done, then the data saved by RAMEXPAND will be lost. The required value for HIMEM is given when RAMEXPA.LOAD is run.

E. RESETTING RAMEXPAND ENTRY POINTS

The entry point into RAMEXPAND that is used when calling it is normally stored in locations 11—12. This entry point corresponds to the first location of the low RAM portion of RAMEXPAND, which is normally at HIMEM. If locations 11—12 are changed or clobbered, they must be reset before using RAMEXPAND from BASIC programs through a CALL 10 or the Applesoft USR function.

F. DECLARING VARIABLES

Variables to be used as parameters in RAMEXPAND command strings should be declared before use. This can be accomplished by simply assigning a value to the variable, prior to calling RAMEXPAND. If this precaution is not taken, RAMEXPAND will either not return the value expected or flag an error. (see section IV.A.3.)

IV. **ERROR HANDLING**

A. DESCRIPTION

Each RAMEXPAND function has an associated error status which is generally passed to a variable stipulated in the command string CM$. The following characteristics describe the error handling process under a variety of conditions.

1. If the command string CM$ is not found, there is no command string to indicate an error status variable. In this case, there is no indication of any error.

2. If no variable is specified for the error status, no error status is returned and the function continues. If no other error occurs, the function will be successful.

3. If a non—existent variable (i.e., a variable which was not declared previously) is specified for error status, there is no indication of any error, even if one occurs. This can be quite confusing in the event that an error does occur, since no indication of this error will be given via the error status variable.

4. If an error status variable is found, but some other variable is not found, an error is returned. No other action takes place.

5. Actions occuring when other errors take place depend upon the situation and the error. In most (but not all) cases, no action will have taken place, after an error condition is encountered.

B. ERROR SUMMARY

1 =	illegal function
2 =	variable not found
3 =	memory block already in use
4 =	memory block not found
5 =	illegal block selection parameter
6 =	memory block is not RAM
7 =	segment name already in use
8 =	segment not found
9 =	illegal segment name
10 =	no program is specified (ending line number precedes starting line number)
11 =	no array specified
12 =	not enough room in extended RAM to store data
13 =	not enough room in normal (low) RAM to recall program
14 =	not enough room in normal (low) RAM to load string

V. **CURRENT LIMITATIONS**

A. The Fetch and Run function (#2) always uses the same BASIC as the calling program used.

B. Overlays must not be larger than the original space, i.e. the space where these overlays will be loaded in the program. As a result, some care must be exercised when overlaying; RAMEXPAND does not currently change “end of program” pointers or move variable tables.

C. The Store array (#5, #15) and Fetch array (#5, #16) functions pass one array at a time, and use the whole array.

1. For the Fetch function, if the saved segment is smaller than the target array, the end of the target array is unchanged, and the data in the segment will overlay the existing data in the array only up to the point where the source data ends.

2. If the the saved segment is larger than the target array, not all of the segment is retrieved. Only data up to the end of the target array is transferred.

VI. **EXAMPLE PROGRAM**

An Applesoft demonstration program has been provided to illustrate some of the RAMEXPAND functions. This program consists of the following files.

DEMO DEMO2 APPEND1 APPEND2 APPEND3 DEMOUTPUT

The program will demonstrate the operation of the following functions.

1. Store array (#5)
2. Fetch array (#6)
3. Store subroutine or program segment (#3)
4. Fetch subroutine or program segment (#4)

In addition, several support functions are used.

1. Initialize RAMEXPAND (#14)
2. Connect Blocks (#9)

A. To execute the demonstration program,

1. Relocate DOS (BRUN MOVEDOS or boot a relocated DOS)

2. Run the loading program, RAMEXPA.LOAD.

3. Run DEMO
   (note: This program will not use the space in the Saturn RAM board where the alternate BASIC is normally loaded. As a result, one can run the program from Applesoft in the Saturn RAM board on an Apple II.)

B. PROGRAM OPERATION

1. The demonstration program will first initialize RAMEXPAND (function #14) and attach the 4K bank with block designation #32 to the system using the connect function (#9). In this way, the space normally occupied by the alternate BASIC is reserved, in the event that it is required.

2. The program will then set up some custom driver routines (used for PROGRAM LISTING menu option) by BRUNing DEMOUTPUT.

3. Three program segments will then be loaded from disk (APPEND1, APPEND2 and APPEND3) and saved by RAMEXPAND in extended RAM using the Store subroutine or program segment funtion (#3)

4. The main portion of the demonstration program (DEMO2) will be loaded and a menu displayed. The following options are available.

   a) LIST — This option will serve to list the program

b) ARRAY DEMO — This option will demonstrate the saving and loading of an array from extended RAM using RAMEXPAND functions.

c) LOAD PROGRAM SEGMENT 1 — This will load the previously stored program segment starting at statement number 5000.

d) LOAD PROGRAM SEGMENT 2 (same as in c)

e) LOAD PROGRAM SEGMENT 3 (same as in C)

f) EXECUTE PROGRAM CURRENTLY IN MEMORY - This will run the program segment which was loaded last.

While the demonstration program may serve as an example of a few of the available RAMEXPAND functions, it by no means exhausts all of the possibilities.

VII. **SUMMARY OF AVAILABLE FUNCTIONS**

RAMEXPAND provides the following functions (specified as the first value in the command string)

0 — no operation

1 — store complete program in extended RAM

2 — fetch and run program from RAM

3 — store subroutine or program segment in extended RAM

4 — fetch subroutine or program segment from extended RAM

5 — store contents of an array in extended RAM

6 — fetch contents of an array from extended RAM

7 — exchange contents of an array between normal RAM and extended RAM

8 — delete extended RAM segment (makes space available again)

9 — connect new block of extended RAM to enable RAMEXPAND to use it.

10 — disconnect block of extended RAM to prevent RAMEXPAND from using it.

11 — fetch total amount of free space in extended RAM

12 — fetch name of “next” segment

13 — (not implemented yet) preload BASIC program from disk file into extended RAM

14 — initialize RAMEXPAND

15 — store contents of Applesoft string array in extended RAM

16 — fetch contents of Applesoft string array from extended RAM

VIII. **COMMAND SYNTAX AND DESCRIPTION**

0 — No—op

No values other than function.

1 — Store program

function, segment name, error status, unused, unused

This function stores all of the current program in a new segment. The new segment is given the name specified in the second value. The segment name may not already exist.

Error status:

0	= success
1	= illegal function
2	= variable not found
7	= name already exists
9	= illegal segment name
12	= not enough room in extended RAM

2 — Fetch and run program

function, segment name, error status, unused, unused

This function retrieves the named segment as a new program. It then runs the new program. If it succeeds, then RAMEXPAND doesn’t return to the calling program.

Error status:

0	= success
1	= illegal function
2	= variable not found
8	= segment not found
9	= illegal segment name
13	= memory full

3 — Store subroutine or program segment

function, segment name, error status, starting line number, ending line number

This function stores a portion of a program in a new segment. The new segment is given the name specified in the second value. The new segment name must not exist. The portion of the program from the starting line number up to and including the ending line number is saved.

Error status:

```
 0 = success
 1 = illegal function
 2 = variable not found
 7 = segment already exists
 9 = illegal segment name
10 = no program area specified
12 = not enough room in extended RAM
```

4 — Fetch subroutine or program segment

function, segment name, error status, start line number, unused

This function retrieves the named segment. It overwrites the portion of the current program beginning at the starting line number. Thus it overlays part of the existing program.

Error status:

```
0 = success
1 = illegal function
2 = variable not found
8 = segment not found
9 = illegal segment name
13= not enough room in normal memory
```

5 — Store array

function, segment name, error status, array name, unused

This function stores the contents of a reel, integer,or string arrays (Integer Basic only) in a new segment. The new segment is given the specified name. The array must be specified by name; i.e., this value may not be a number. For storing Applesoft string arrays, use function #15.

Error status:

```
 0 = success
 1 = illegal function
 2 = variable not found
 7 = segment name already exists
 9 = illegal segment name
11 = no array specified
12 = not enough room in extended RAM
```

6 — Fetch contents of array

function, segment name, error status, array name, array length

This function retrieves the named segment and stores the contents in the named real, integer, or string array Integer Basic only). The array must be specified by name. If the array length value is specified, it must be a variable name. If it is specified, RAMEXPAND will return the number of bytes actually stored in the array in this variable. This can be used to determine how much data was returned. The number must be divided by the size of an array element to determine how many elements it represents. For integers, the size is 2 bytes. For reals, the size is 6 bytes. For fetching Applesoft string arrays, use function #16.

Error status:

```
 0 = success
 1 illegal function
 2 = variable not found
 8 = segment not found
 9 = illegal segment name
11 = no array specified
```

7 — Exchange array

function, segment name, error status, array name, array length

This function exchanges the contents of an array in normal RAM with the contents of an array in extended RAM. Other than the exchange, this function acts just like the Fetch Array function. The array must be specified by name. If the array length value is specified, it must be a variable name. If if is specified, RAMEXPAND will return the actual number of bytes stored in the array in this variable. This can be used to determine how much data was returned. This number should be divided by the number of bytes per array element to determine how many elements it represents. For integers, the size is 2 bytes. For reals, the size is 6 bytes.

Error status:

```
 0 = success
 1 = illegal function
 2 = variable not found
 8 = segment not found
 9 = illegal segment name
11 = no array specified
```

8 — Delete segment

function, segment name, error status, unused, unused

This function deletes the segment named. This makes the space in extended RAM available for other uses.

Error status:

0 = success
1 = illegal function
2 = variable not found
8 = segment not found
9 = illegal segment name

9 — Connect blocks

function, block selection, error status, unused, unused

This function identifies new blocks of memory for use by RAMEXPAND. The block selection parameter was described previously (ATTACHING MEMORY BLOCKS, section II.E.)

COMMON VALUES OF BLOCK SELECTION PARAMETER:

The following table gives some common block selection parameters for a variety of RAM boards and situations. These include cases where space is to be reserved for BASIC, DOS and RAMEXPAND in the Saturn 32K, 64K and 128K RAM boards.

BOARD	**USE ALL OF IT**	**RESERVE SPACE FOR:**		
		BASIC +RAMEXPAND	**DOS +RAMEXPAND**	**DOS+RAMEXP. + BASIC**
16K	40+sl	N/A	N/A	N/A
32K	120+sl	48+sl	40+sl	32+sl
64K	1016+sl	* 432+sl 760+s1	* 424+sl 760+sl	* 416+sl 760+sl
128K	4088+sl	* 432+sl 3832+s1	* 424+sl 3832+sl	* 416+sl 3832+sl

* note: in order to attach these blocks, two consecutive connect function calls are required, the first to specify the blocks to be used in the first “32K section”, and the second, to specify blocks in the rest of the card.

Error status:

0 = success
1 = illegal function
2 = variable not found
3 = block already in use
5 = illegal block selection parameter
6 = RAM not in specified slot

10 — Disconnect blocks

function, block selection, error status, return—name, unused

This function disconnects blocks of memory from use by RAMEXPAND. The specified blocks must be empty or RAMEXPAND will not disconnect them. The block selection format is the same as specified in the “connect” function. If the return—name value is specified as a variable name, and if a segment still remains stored in a block, the segment name will be returned in the variable named.

Error status:

0 = success
1 = illegal function
2 = variable not found
4 = block not in use
5 = illegal block selection parameter
? = block not empty. error status is segment name.

11 — Retrieve total amount of free space

function, unused, error status, unused, free space variable

This function computes the amount of free space in extended RAM. If a variable name is specified for the free space variable, the total number of bytes is returned in the variable.

Error status:

0 = success
1 = illegal function
2 = variable not found

12 — Retrieve next segment name

function, segment name, error status, length variable, unused

This function looks up an existing segment name. It then returns the next name following the specified name. This may be used to step through all the segments to see which names are used. The segment name value must be a variable name to have a new name returned. If the length variable is specified, the length of the new segment will be returned in the length variable. To get the first segment name, zero should be specified for the starting segment name. If no segments follow the specified segment, the name returned will be zero.

Error status:

0 = success
1 = illegil function
2 = variable not found
8 = segmetit name not found
9 = illegal segment name

13 — Preload program from disk file

(not implemented at this time)

14 - Initialize RAMEXPAND

function, unused, error status, unused, unused

This function restarts RAMEXPAND from scratch. All blocks are disconnected, and any existing data is lost.

Error status:

0 = success
1 = illegal function

15 - STORE APPLESOFT STRING ARRAY

function, segment name, error status, array name, unused

This function stores the contents of a string array (Applesoft only) in a new segment. The new segment is given the specified name. The array must be specified by name, i.e. This value may not be a number.

Error Status:

0 = success
1 = illegal function
2 = variable not found
7 = segment name already exists
9 = illegal segment name

11 = no array specified
12 = not enough room in extended RAM

16 — Fetch contents of Applesoft String array

function, segment name, error status, array name, unused

(For use with Applesoft string arrays only!)
This function retrieves the named segment and stores the contents in the named Applesoft sring array. The array must be specified by name.

Error Status:

0 = success
1 = illegal function
2 = variable not found
8 = segment not found
9 = illegal segment name
11 = no array specified
14 = memory full

Chapter 6

DOS PSEUDO—DISK

This software package enables one to use the Saturn RAM Board(s) for storing programs and data in a very similar manner as is done on disk, Of course, the RAM board does not in any way resemble a disk drive; however, through appropriate software, DOS can be fooled into thinking that the card(s) is just another disk drive. As a result, applications programs which use DOS for saving and loading programs and data will also see the Saturn RAM board as a disk drive.

In order to be able to use the Saturn RAM Board as a pseudo—disk, controlling software routines must be loaded and some initialization accomplished. The DOS PSEUDO DISK package consists of three programs which serve to perform this loading and initialization of the PSEUDO DISK. These files must be present on the same disk in order to set—up and install the PSEUDO DISK.

PSEUDO DISK —	Menu driver Applesoft program which is used to set up the PSEUDO DISK parameters and install the pseudo disk.
PSEUDO.NRM —	Binary program which contain the disk drivers and patches to DOS for operation with a normal (not relocated DOS)
PSEUDO.MVD —	Binary program which consists of driver software and patches to DOS for operation with the relocated DOS.
PSEUDO PARAMETERS-	File updated by PSEUDO DISK program with system parameters, location, and type of memory boards present, etc.

I. **FEATURES AND REQUIREMENTS OF THE PSEUDO DISK SYSTEM**

The pseudo—disk is designed to operate with both standard and relocated DOS 3.3 or 3.2.

The pseudo—disk system will work with one or more Saturn RAM boards, making available all of this memory for storage. A maximum of 256K can be used for the PSEUDO DISK.

A feature has been provided which allows reservation of space in the RAM board for BASIC, if access to the alternate BASIC (Integer on an Apple II plus; Applesoft on an Apple II) is desired.

There are two basic steps which must be taken in order to be able to use the PSEUDO DISK. These are:

1. Set up the PSEUDO DISK

2. Install the PSEUDO DISK

These must be performed in the order given above.

II. **SETTING UP THE PSEUDO DISK**

This step primarily involves telling the system where the memory cards are, and what portions, if not all, are to be used.

To set it up, Run the Applesoft program PSEUDODISK. Both PSEUDO.NRM and PSEUDO.MVD must be present on the disk along PSEUDO—DISK.

A menu will be displayed:

```
                     DOS PSEUDO DISK
          COPYRIGHT (1982), SATURN SYSTEMS, INC.


             <1> LOOK AT PSEUDO DISK SET—UP
             <2> SET—UP PSEUDO DISK
             <3> INSTALL PSEUDO DISK
             <4> RECONNECT PSEUDO DISK
             <5> EXIT
```

Select option 2. The screen will display:

```
SLOT 5           DRIVE 1         DIR.             SECS 4
                  BANK                             BANK
SLOT            12345678         SLOT             12345678
 0                                4
 1                                5
 2                                6
 3                                7
-------------------------------------------------------------------

B = BASIC        Y = USED        N = NOT USED

-------------------------------------------------------------------

                 <1> CHANGE SLOT CONTENTS
                 <2> CHANGE DISK PARAMETERS
                 <3> EXIT
```

Enter 1 to tell the system where the memory cards are.

WHICH SLOT?

Enter the slot of the first memory card. The system will prompt for the type of card present 128K, 64K, 32K, 16K.

Enter the card type (ex. 128K)

If this card was in slot 0 the system will ask:

DO YOU WANT TO SAVE ROOM FOR BASIC?

Enter the appropriate response. If N, the system will ask, one bank at a time, whether you want to use this bank. If the relocated DOS is being used, be sure to reserve Bank 2 of the 64K or 128K board which contains the relocated DOS.

Repeat this procedure for all the memory cards present in the system.

Next, select option 2 to change the disk parameters. The following options will be displayed:

```
<1> CHANGE SLOT AND DRIVE
<2> CHANGE DIRECTORY SIZE
<3> EXIT
```

Select the appropriate option.

1) To change the slot and drive for the PSEUDO DISK. The current values are displayed at the top of the screen just under the Copyright notice.

2) To change the number of directory sectors to be allocated for the PSEUDO DISK (default = 4 sectors)

Once all the parameters have been entered, exit this menu. Then, to exit back to the main menu select option 3.

The file PSEUDO PARAMETERS will then be updated with the new parameters, etc., and the main menu displayed. The PSEUDO DISK is not active at this time.

III. **INSTALLING THE PSEUDO DISK**

Once the disk parameters, location and type of memory boards have been entered (above), the PSEUDO DISK is ready to be installed.

Select option 3.

The system will load the appropriate Binary program PSEUDO NRM or PSEUDO MVD, depending upon whether a normal or relocated DOS is being used and initialize the PSEUDO DISK with an empty directory. The PSEUDO DISK can be accessed in the same manner as a real disk, using the slot and drive designation previously specified (default slot 5, Dl). Example: CATALOG S5, Dl will display the catalog of the PSEUDO DISK.

IV. **RECONNECTING THE PSEUDO DISK**

Because the PSEUDO DISK system consists of special drivers and some patches to DOS, every time the system is re–booted after the PSEUDO DISK has been installed, these patches are overwritten, resulting in disconnection of the PSEUDO DISK. Any files placed on the PSEUDO DISK are still present there, after the reboot (as long as the power remains on), however they are inaccessable until the driver routines and patches to DOS are re–installed.

Installation of these patches can be accomplished using option 3 of the PSEUDO DISK program, however this will result in the directory being initialized, and any files present on the PSEUDO DISK being wiped out. The patches can be re–installed without disturbing the PSEUDO DISK directory by selecting option 4 of the menu in the PSEUDO DISK program.

V. **PRECAUTIONS**:

A. Although checks have been placed in the installation and reconnection routines in order to prevent some conflicts between memory usage by the PSEUDO DISK and the relocated DOS, care should be taken not to inadvertently destroy data on the PSEUDO DISK by loading programs or data into portions of the card(s) being used by the PSEUDO DISK (ex. loading BASIC into Bank 1 of the board in slot 0, when this bank is being used by the PSEUDO DISK.

B. INITIALIZING DISKS

Since the RWTS subroutine within the DOS present in memory has been patched to operate with the pseudo–disk. Care must be taken when initializing disks. When a diskette is initialized (using INIT function) with the pseudo–disk installed, a copy of the patched DOS is written to the diskette. This diskette will not boot properly because of the patches to DOS. It is therefore recommended that diskettes be initialized only under a standard DOS, prior to installation of the pseudo–disk, so as to avoid this problem.

C. It is not necessary to run the set–up portion of the PSEUDO DISK every time it is installed, but only when a change in configuration is desired (when the memory card(s) location(s) are changed).

VI. **USING THE PSEUDO DISK**

Once the pseudo—disk has been initialized and installed(by running the appropriate BASIC program or BRUNing the SATURN DISK program), it can be used as a standard disk drive. Its directory will be empty and files can be saved on it like a real disk drive. The number of files that can be stored on the pseudo—disk is limited to the amount of memory being used for it. (Saturn 32K boards, 64K, 128K and 16K cards)

Due to the unique organization of the PSEUDO—DISK (32 sectors/track), standard track and nibble copy programs cannot generally be used to copy data to or from it. In fact, FID must be modified to enable it to transfer files properly from a real disk drive (16 sectors) to the pseudo disk (32 sectors). This modification is accomplished by running the program, MOD, provided on the distribution diskette included with the Saturn 64K and 128K RAM boards.

MOD will modify FID so that it can be used with the PSEUDO—DISK, as well as with the relocated DOS (see Chapter 4). The modified FID can be used as a direct replacement for FID (as distributed on the DOS 3.3 system master), with or without a PSEUDO—DISK or the relocated DOS.

The data will remain on the pseudo—disk as long as power is applied, or until the data is deleted. The data is still present even after a re—boot on the system.

VII. **HOW IT WORKS**

The PSEUDO DISK system consists of the following programs:

1. PSEUDO DISK— This is an Applesoft program which provides the interface between the user and the machine language programs (PSEUDO.NRM, PSEUDO.MVD) that do the actual patching of DOS and installation of the driver routines for the PSEUDO DISK, for emulation of a disk drive. The program generates a binary data file PSEUDO PARAMETERS which contains information regarding the location and types of RAM boards in the system as well as the slot and drive specified for the PSEUDO DISK. This file is updated whenever the PSEUDO DISK is set—up (option 2 of the main menu.

2. PSEUDO.NRM— This program does the actual installation of the PSEUDO DISK and initialization of the system (including the directory, if desired). The driver routines for the PSEUDO DISK are located between the file butters and start of DOS, with HIMEM being adjusted downward.

3. PSEUDO.MVD— This program does the actual installation

(and is executed by the BASIC program, PSEUDO DISK) and initialization of the PSEUDO DISK when the relocated DOS is used. The driver routines for the PSEUDO DISK are located just below the interface routines to the relocated DOS ($BEOO) with HIMEM set to protect it from being overwritten.

Chapter 7

PASCAL PSEUDO—DISK

The enclosed SATURN SYSTEMS PASCAL diskette includes the following programs for use with Apple PASCAL version 1.1:

PSEUDO:	A program to configure the system. (i.e. to tell the system where the memory cards are located, This needs to be run only upon installation, unless your memory card(s) are moved.)
ATTACH:	A set of programs which automatically install the PASCAL PSEUDO—DISK upon booting, if desired. If it is already installed, it leaves it in place upon re-booting.
*FASTCOPY:	A program to make a fast copy, from any drive to or from the PSEUDO—DISK.
*FILEMARKER:	A program to select ("mark") the names of files to be "fast copied" to the PSEUDO—DISK upon booting. This is done while viewing the directory.
*FILEMOVER:	A program to move "marked files from any drive to the PSEUDO—DISK with "fast copy" speed.

Intended for use as a SYSTEM STARTUP program, provision has been made for the following:

1. Chaining to a user STARTUP CODE program.
2. Loading only those files desired, leaving files required only for booting on the boot drive.
3. Not over—writing files on PSEUDO—DISK during rebooting.
4. Extensive error checking during file transfer.

(The following include source textfiles.)

* SLIDESHOW:	A demonstration program that reads several "pictures" from the PSEUDO—DISK and displays them on the high resolution screen.
GRAPHICS:	A demonstration program which illustrats saving graphics generated within a program.

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I. **<u>PASCAL</u> <u>PSEUDO—DISK</u> <u>SYSTEM</u> <u>REQUIREMENTS</u>**:

A. HARDWARE REQUIREMENTS:

An Apple II with 48K of on board memory, a least one disk drive (1—5 drives may be used) and a Saturn Systems Inc. 32K, 64K or 128K RAM Board, are the minimum hardware requirements, for PASCAL pseudo—disk operation.

Any of the following expansion RAM cards may be used in slot zero:

A) Apple Language Card
B) 16K RAM card
C) Any Saturn RAM Board (32K, 64K, 128K)

Additional Saturn RAM Boards may also be placed in additional slots. The memory on these cards (up to a maximum of 256K) may be used as a PSEUDO DISK.

B. SOFTWARE REQUIREMENTS:

The PASCAL Operating System version 2.1, and the Saturn Systems PASCAL Diskette.

II. **<u>VOLUME</u> <u>ASSIGNMENT</u> <u>AND</u> <u>DISK</u> <u>CAPACITY</u>**:

The PASCAL Operating System, version 2.1 assigns volume numbers to disk drives in the following order: *4,5,11,12,9,10.* The Saturn PSEUDO DISK is installed as Volume #10, leaving room for up to five additional drives to be installed.

Unlike normal disk drives, PSEUDO DISK memory boards may be installed in any available slot. A maximum of 256K may be installed as a Saturn PSEUDO DISK yielding 506 blocks available to the user (after allowing 4 blocks for the disk directory and 2 for the boot strap).

The following table shows the amount of available memory for various memory configurations.

Language Card Note:

An article in the December 1981 issue of “SOFTALK” magazine entitled “Make your Apple More Flexible” describes a method of modifying the Apple Language Card in such a manner as to disable the Autostart ROM. With this modification, the capacities listed for a 16K card may be obtained while using an Apple Language Card.

AVAILABLE CAPACITY IN BLOCKS
(After allowing 4 blocks for the directory and 2 boot blocks)

Saturn Boards Installed with the following:

Saturn Systems Board Type:	One Board, Slot Zero:	+Language Card:	+16K Card:	+32K Card:
32K Board:	26	50	58	90
64K Board:	90	106	122	154
128K Board:	218	218	250	284
Using Two:				
32K Board:	90	106	122	154
64K Board:	218	218	250	284
128K Board:	474	474	506	506

III. **<u>SETTING</u> UP THE <u>PASCAL</u> <u>PSEUDO–DISK</u>: <u>(configuration)</u>**

A. BACK UP YOUR PASCAL DISKETTE BEFORE PROCEEDING:

The Saturn Systems PASCAL Diskette is your key to using your Saturn RAM Board under PASCAL. For this reason we believe you should format a diskette and make a backup copy. This is easily done using the SYSTEM FILER and the “wild card” provision.

B. USING PSEUDO.CODE TO CONFIGURE THE SYSTEM:

All reference to the boot diskette in this chapter will refer to the diskette with SYSTEM.PASCAL on it. For a two stage boot, this will be the second stage diskette. (This one with SYSTEM ·PASCAL.)

1. With the SYSTEM FILER, transfer the following files from the Saturn Systems PASCAL Diskette to your boot diskette.

a) PSEUDO.CODE (The configuration program)
b) ATTACH.DATA (Used by SYSTEM.ATTACH)
c) ATTACH.DRIVERS (Used by SYSTEM.ATTACH)
d) PARAM.DATA (Used by PSEUDO.CODE)

2. Execute the file PSEUDO.

A menu will be displayed:

```
                    APPLE PASCAL PSEUDO DISK
                   COPYRIGHT 1982 Kenneth Roe
               COPYRIGHT 1982 Saturn Systems, Inc.

                   <1>  LOOK AT CONFIGURATION
                   <2>  CHANGE CONFIGURATION
                   <3>  PUT CONFIGURATION IN
                        ATTACH.DRIVERS AND EXIT
                   <4>  EXIT
```

a) Select option 2 and modify the slot contents to match your system configuration, entering the location and type of all the memory cards in the system. Next, modify the parameters to set the directory block count (default=4). NOTE: The directory block count does not include the boot blocks. Thus, 6 blocks are not available for file storage.

b) Select option 3 of the main menu to install the configuration in ATTACH.DRIVERS and to write out the configuration parameters to PARAM.DATA. ATTACH.DRIVERS will then be set up for the given system configuration.

3. Now transfer the files, SYSTEM.ATTACH (from the distribution diskette), ATTACH.DRIVERS (from your boot disk) and ATTACH.DATA (also from your boot disk) to a separate boot disk. These are all the files that are necessary for installation of the pseudo—disk.

4. Now cold boot this disk, by turning the power off and back on again with the newly created boot disk containing SYSTEM.ATTACH, ATTACH.DRIVERS, and ATTACH.DATA. SYSTEM.ATTACH will install the pseudo—disk using the files ATTACH.DRIVERS and ATTACH.DATA which have been set up for it.

5. Now go to the SYSTEM.FILER by typing “F”. When the SYSTEM.FILER prompt line appears, type “V” to get a list of volumes on line. If all has gone well, you should observe that the PSEUDO DISK is installed as volume #10, with the volume name “PSEUDO”.

Every time you boot with your modified root volume diskette, the PSEUDO DISK will be installed automatically for you. By transferring the files SYSTEM.ATTACH, ATTACH.DRIVERS and ATTACH DATA another diskette you will be able to install the PSEUDO DISK using that diskette.

If any of the memory cards are removed or their locations changed, it will be necessary to run PSEUDO.CODE again to re-configure the system. Go back to the original boot disk which contains PSEUDO.CODE, PARAM.DATA, ATTACH.DRIVERS and ATTACH.DATA, and repeat steps 2 - 4 above.

SUMMARY:

1. Make sure that the files listed on the proceding page, are present on the boot diskette.

2. Run PSEUDO, from the boot diskette. This will insure PSEUDO will write out ATTACH.DRIVERS on the boot diskette.

3. Transfer ATTACH.DRIVERS and ATTACH.DATA from this disk to a new boot disk.

4. Transfer SYSTEM.ATTACH to this new boot disk.

5. Install the new boot disk in drive #4 and turn the power off, then turn the power on again to install the PSEUDO DISK.

IV. **DETAILS OF THE INSTALLATION PROCESS**:

The PASCAL Operating System looks for a SYSTEM.ATTACH file during one stage of execution of SYSTEM.PASCAL during the boot process. If SYSTEM.ATTACH is found, it is executed prior to running SYSTEM STARTUP. The Saturn Systems program, PSEUDO is designed to modify the ATTACH DRIVERS code file, for permitting transfer of information about memory card locations, etc. SYSTEM ATTACH then uses the ATTACH DRIVERS file along with the ATTACH DATA file to install the PSEUDO DISK. The Operating System then looks for a SYSTEM STARTUP file to execute next. If SYSTEM STARTUP is not found, the process ends by displaying the command line prompt.

V. **USING FASTCOPY**

A. PROGRAM DESCRIPTION:

FASTCOPY is a very fast loader program designed for use with the Saturn PSEUDO DISK under PASCAL.

Uploading a full diskette (280 blocks) from an Apple minifloppy to the PSEUDO DISK may be accomplished in about 20 seconds.

Downloading a full diskette (280 blocks) from the PSEUDO—DISK to an Apple minifloppy may be accomplished in about 30 seconds.

B. INTENDED USE:

FASTCOPY was designed to be used to quickly transfer the contents of a minifloppy diskette to the PSEUDO DISK.

The fast access times of the PSEUDO DISK may be utilized for files thus transferred.

C. EXECUTING FASTCOPY

Warning: Fastcopy is designed to over–write any files existing on the destination diskette. (See “intended use” above and “notes” below.)

FASTCOPY may be executed from any Volume or Drive.

Upon execution, FASTCOPY will present a menu for you to select U)ploading or D)ownloading or Q)uit.

FASTCOPY will then ask for source or destination volume, as appropriate, and perform the task indicated by your answers.

D. NOTES ON THE USE OF FASTCOPY:

FASTCOPY transfers the directory of the source and all the blocks on the source or all the blocks that will fit on the destination, whichever is the smaller number. FASTCOPY will then modify the directory of the destination to show only those files transferred in the event the source volume contained more files than would fit on the destination volume.

FASTCOPY makes a block for block transfer, moving the directory and used and unused blocks, just as they appear on the source. Thus, it is important that the source volume be crunched (or have no unused blocks between files) in order to transfer as many files as possible. If the destination is larger than the source volume, then complete transfer will always be obtained.

FASTCOPY makes changes to the directory of the destination volume after the transfer to show the names of the files transferred. If all the files had not been transferred as expected, based on the file space available on the destination volume, it is probably because unused blocks were transferred. The solution to this problem is to crunch the source and run FASTCOPY again.

FASTCOPY does not change the name of the PSEUDO DISK to that of the source volume name. Thus the Pseudo–disk will retain the volume name “Pseudo” to distinguish it from the source volume that you may desire to leave on line. When the contents of PSEUDO are transferred back to a minifloppy, the original name of the source volume is restored on the directory of that diskette. This eliminates any problems that might otherwise be encountered by having two volumes on line with the same name.

E.   ERROR CONDITIONS FLAGGED BY FASTCOPY:

FASTCOPY will inform the operator when the following conditions exist:

Condition:	Action taken:
Source volume not on line:	Message displayed: "Error reading source volume." "Press any key to return to the menu"
Destination volume not on line:	Similar action is taken, with destination volume cited in message.
Boot volume not on line at exit:	Message displayed: "Place Boot Disk in drive #4" "Press any key to return to menu"

VI. **USING FILEMARKER**:

A.   PROGRAM DESCRIPTION AND INTENDED USE:

FILEMARKER is a program that displays the directory of a particular diskette and permits "marking" of files for transfer by the program FILEMOVER. FILEMARKER builds a file of the selected file names along with the volume name of the source diskette and writes it to the Prefix Volume in a file named FILEMARKER.DATA.

FILEMARKER displays the source and destination volume names along with the contents of the source directory and the current amount of space available in blocks on the destination.

The intended use of FILEMARKER is to build a list of files to be moved by FILEMOVER automatically upon booting.

B.   EXECUTING FILEMARKER:

FILEMARKER may be executed from any drive or volume. The program will ask for the source drive number and display the contents of the directory in the drive indicated by your response. (The drive must be either 4 or 5.) Eleven filenames of the directory are displayed at a time, along with the name of the source volume and the destination volume. The destination is assumed to be "Pseudo" on volume #10. This is built into the program, as the purpose of FILEMARKER and FILEMOVER is to move files to the Pseudo–disk automatically. (It is presumed that this will be desired upon booting, to put the PASCAL system or application software on Pseudo–disk,) Along with the above information, FILEMARKER displays a indicator which points to a file in the directory. This pointer may be moved up or down the list of files with the Left and Right Arrow keys. A file may be selected for transfer or removed from the list to be transferred by pressing the spacebar, while the indicator is pointing to its name in the directory.

The amount of space left on Pseudo–disk after each file selection is made is indicated in the upper right corner of the screen. The file’s number position in the directory is indicated at the bottom of the screen along with the indication of the file’s status as being “marked” or “unmarked” for transfer. Also, an asterisk is printed by the file’s name to indicate this condition.

The Left and Right arrow keys can be used to scroll the display so as to be able to display all of the files in the directory.

A “Help” screen is provided and will appear when FILEMARKER is executed. In order to see the directory it will be necessary to press Control A. The Help screen may be viewed at any time by pressing Control A.

C. ERROR CONDITIONS FLAGGED BY FILEMARKER:

FILEMARKER will inform the operator if the following error conditions exist: (After displaying the appropriate message, FILEMARKER will exit if the boot volume is on line or prompt for the boot volume and then exit.)

Condition:	Action taken:
No disk in source drive:	Message displayed: “Source volume is off line”
Pseudo–disk not installed:	Message displayed: “Pseudo is not installed”
No files on source disk:	Message displayed: “Source directory is empty”
No files marked by operator:	Message displayed: “No files marked from source
Prefix volume not on line:	Message displayed: “Insert program disk in any drive, press Space to create file” (At this point) Pressing the Escape key will exit the program without creating a file.

VII. **USING FILEMOVER**:

A. PROGRAM DESCRIPTION AND INTENDED USE:

FILEMOVER is a utility program designed to read a data file (FILEMARKER.DATA) containing a list of filenames that reside on a floppy diskette and transfer these files from that disk up to the Pseudo—Disk. It has been designed to be a startup program whose function is to pre—load the Pseudo—Disk with files that are regularly required by the user when the system is first turned on. A provision has been made for execution of a user startup program when FILEMOVER has finished.

B. EXECUTING FILEMOVER:

If FILEMOVER is renamed SYSTEM.STARTUP, it will be run automatically at boot—time. (Providing it is on the diskette you are using to boot the system.) However, if this is not desired it may be started by executing the program whenever the Command prompt is displayed. This may be done with FILEMOVER on any volume or drive. FILEMOVER has no menu options, it will run automatically requiring operator response only when a condition is detected that requires operator intervention. (These conditions are listed below.)

If you desire another program to be run upon completion of FILEMOVER, such as a startup program, merely name your program STARTUP.CODE. FILEMOVER attempts to execute a file named STARTUP.CODE as it finishes. Finding none, it exits normally, and the Command line appears.

C. NOTES ON THE USE OF FILEMOVER:

(The file FILEMARKER.DATA mentioned below is created by the program FILEMARKER.)

FILEMOVER attempts to read FILEMARKER.DATA from the prefix volume. (This will be the same as the Root Volume name at boot time.) FILEMOVER reads the volume name contained in FILEMARKER.DATA. This volume name points to the diskette containing the files to be transferred. FILEMOVER then looks at that volume for the files and transfers them to Pseudo—disk if they are present. A report is made to the screen as each file is transferred and notice is given of each file requested but not found.

If a file with the same name is already present on Pseudo—disk, as may be the case when rebooting, then no transfer takes place. The file present on Pseudo—disk is not over—written. FILEMOVER then continues moving files not already present but requested, if there are such files.

Except for system files, if a file suffix is not .TEXT, or .CODE, that file will be copied as a data file.

Stating the last paragraph another way: SYSTEM.EDITOR, SYSTEM:FILER, etc. will be moved properly as will files ending in PROGRAM will be transferred, but will be marked in the disk directory as a data file. A file labelled as such cannot be executed by the system. Without moralizing unduly, let it be said that if the file suffix reflects the type of file that it represents you should have no problems.

D. ERROR CONDITIONS FLAGGED BY FILEMOVER:

Condition:	Action taken:
Pseudo not installed:	Message displayed: “Pseudo not installed” “Pressing any key will exit program
File FILEMARKER not found:	Message displayed: “List of files not found on disk” “Pressing any key will exit program
Source volume not on line:	Message displayed: “Insert data diskette in any drive”
A file is not found:	Message displayed: “File name not found on source disk” (No transfer is attempted)
File handling error: (Opening or closing error)	Message displayed: “Error in copying file” “Pressing any key will exit” (We beat a hasty retreat!)
Boot Volume is not on line: (As we attempt to exit)	Message displayed: “Insert boot disk in boot drive and hit any key.”

VIII. **USING THE GRAPHICS DEMONSTRATION PROGRAMS**:

The following demonstration programs as supplied on diskette, are designed to run in a system with a minimum of two drives. For Slideshow, an additional requirement is that of a pseudo—disk with at least 64 blocks free to hold the 4 high resolution screens. In practical terms, at least two 32K cards or a 64K card or larger must be installed.

These programs are included for their tutorial value only and well—documented source is provided. It should be possible to modify the programs to show one slide at a time with a single drive system and a single 32K card, if desired.

The graphics demonstration programs provided on the Saturn Systems PASCAL diskette are meant to illustrate the way in which graphics programs may move graphics to and from the Pseudo—disk.

A. EXECUTING SLIDESHOW:

(The following expects that a boot volume has been prepared according to instruction in this chapter regarding installation a Pseudo—disk automatically upon boot up, and sufficient memory and drives are available.)

1. Boot up a two—drive system using Applel.

2. Place the Saturn Systems PASCAL diskette in drive number 2. (This is volume #5 under PASCAL)

3. When the Command line prompt appears, type: “X”.

4. In answer to the question “Execute what file?”, type: “#5:SLIDESHOW”

5. Press the SpacEbar to begin the show, repeated pressing of of the Escape key will eventually exit the program.

IX. USING THE GRAPHICS PROGRAM:

The graphics program may be run with a single 32K card installed in slot 0 and a boot diskette set up to install this as a PASCAL Pseudo—disk.

1. Complete steps one through five listed under USING SLIDE—SHOW.

2. Answer the question “Execute What File?” by typing: “#5: GRAPHICS”.

3. As GRAPHICS begins, a single pixel is presented on the screen and you may have to turn the brightness and contrast up on your monitor to see it.

4. Holding down the button on Paddle 1, you may draw lines on the screen using the control knobs on the two paddles. (One is for horizontal, the other vertical.)

5. When you are quite content with your doodle, you may press the button on Paddle 0 to watch the contents of the screen be stored to the Pseudo—disk and return to the screen.

6. The purpose of GRAPHICS is to present a program that may be easily modified by the user to store graphics generated within a program to the Pseudo—disk. This is a different situation than attempting to load a binary file that represents a “Picture”. This program has been provided (along with a well—documented text file) solely for its tutorial value.

CHAPTER 8

CP/M PSEUDO DISK

The CP/M PSEUDO DISK is a software package which sets up Saturn RAM boards for use as a fast “RAM” disk drive under the CP/M operating system. It will operate with Saturn 32K, 64K, 128K RAM boards, as well as standard 16K RAM cards. Patches are made to the BIOS portion of CP/M to fool it into thinking that the memory on the board(s) is just another disk drive. In this respect the RAM board is made to emulate a disk drive, and as a result, applications programs are be able to take advantage of dramatically increased data transfer rate and throughput.

The software included in this package serves to set up the PSEUDO DISK system, patch CP/M and install the controlling routines. These functions are performed by the following programs:

PSEUDO.BAS	This program is used to set up the PSEUDO DISK and includes a facility for telling the system where the memory cards are, as well as the entry of disk parameters. The program patches these parameters into the PSEUDO DISK installation programs INIT.COM and INIT2.COM.
PSEUDO.COM	This machine language program actually sets up the PSEUDO DISK driver routines with appropriate parameters entered during the set—up procedure. The program is loaded and executed by PSEUDO.BAS. INIT.COM and INIT2.COM are created from PSEUDO.COM.
INIT.COM	When this program is executed, it patches the routines. It then initializes the PSEUDO DISK
INIT2.COM	This program performs the same function as INIT.COM, except that it does not erase the directory after installing the PSEUDO DISK driver routines.
PARAM.DAT	This file contains the parameters entered during the set—up procedure (drive for PSEUDO DISK, location and types of memory cards, etc) and is used by PSEUDO.BAS to generate INIT.COM and INIT2.COM.

There are two basic steps which must be taken prior to using the PSEUDO DISK:

1. The PSEUDO DISK must be set up.

2. The PSEUDO DISK drivers must be installed and the system initialized.

I. SETTING UP THE PSEUDO DISK

This step involves telling the system where the memory cards are (which slots) and what portions of these are to be used. In addition, the drive to be assigned as the PSEUDO DISK and the number of directory blocks to be allocated is also specified.

The following files are required in order to set up the PSEUDO DISK.

```
PSEUDO.BAS
PSEUDO .COM
INIT. COM
INIT2 .COM
PARAM. PAT
```

These files should be transferred to a disk containing the CP/M operating system, and installed in drive A.

1. Load MBASIC and RUN “PSEUDO”.

2. The following menu will be displayed:

```
                    CP/M PSEUDO DISK

          COPYRIGHT 1982, SATURN SYSTEMS, INC

           <1> LOOK AT PSEUDO DISK SET—UP

           <2> SET UP THE PSEUDO DISK

           <3> SET UP INIT.COM AND INIT2.COM
               AND EXIT
           <4> EXIT

          WHICH OPTION?
```

At this point, select option #2. The system will then display:

```
                          CP/M PSEUPO DISK

      DRIVE C:                  DIRECTORY BLOCKS 1

      SLOT          BANK        SLOT          BANK
                  12345678                  12345678
       0                         4
       1                         5
       2                         6
       3                         7

---------------------------------------------------------------------
              Y=USED    N=NOT USED    C=RESERVED FOR CP/M

                       (1> CHANGE SLOT CONTENTS
                       <2> CHANGE DISK PARAMETERS
                       <3> EXIT

                           WHICH OPTION?
```

Now select option 1 to enter slot contents. The system will then prompt:

```
                            WHICH SLOT?
```

At this point, enter the slot # of the first memory card.

The system will then prompt for the type of card present (16K, 32K, 64K, 128K) Select the appropriate type.

The system will then ask for the banks to be used in this card. Enter Y for each bank to be used, N for those banks to be reserved. If the card is in slot 0, a request will be made as to whether space should be reserved for CP/M (i.e. 56K CP/M)

Repeat this sequence until all cards to be used by the PSEUDO DISK are specified.

Next, enter the disk parameters by selecting option 2.

The option will display:

```
                           <1> CHANGE DRIVE

                           <2> CHANGE NUMBER OF DIRECTORY BLOCKS

                           <3> EXIT
```

1. Select option 1 to change the drive to be assigned as the PSEUDO DISK (Default = C:)

2. Select option 2 to change the number of directory blocks (Default = 1)

NOTE: Each directory block can hold 32 directory entries.

Once all of the cards have been specified and the parameters entered, select 3 to exit and 3 once again to exit back to the main menu. The system will update the PARAM.DAT file with the new parameters.

The last thing that must be done prior to installation of the PSEUDO DISK is to set up the INIT.COM and INIT2.COM files.

These programs are what are used to install the PSEUDO DISK by patching CP/M. They are set up with the parameters entered during the set—up procedure (option 2).

Select option 3 at this time to set up INIT.COM and INIT2.COM. The system will access the disk and pause frequently during this set up procedure.

Once these files have been set up, the program will terminate, exiting back to CP/M system level.

II. **INSTALLING THE PSEUDO DISK**

After the PSEUDO DISK has been set up, it is installed by simply executing the file INIT.COM. This action results in the driver routines to the PSEUDO DISK being loaded into the I/O configuration block and CP/M BIOS being patched to utilize these drivers. The last step in this initialization involves erasing the directory of the PSEUDO DISK.

The program INIT2.COM is identical to INIT.COM except for the fact that the directory is not erased.

This is useful if CP/M had been COLD Booted after the PSEUDO DISK had been installed, and access to the files present on the PSEUDO DISK prior to the boot is desired. INIT2.COM will not wipe out these files, whereas INIT.COM would destroy them because it would erase the directory.

NOTE: It is not necessary to run the set—up portion of the PSEUDO DISK every time the PSEUDO DISK is to be installed. It is only necessary to set up the PSEUDO DISK when a change in the configuration is desired. (i.e. when the memory card locations are changed or the disk parameters are modified) In fact, the only files which are necessary for installation of the PSEUDO DISK (after set—up has been accomplished) are INIT.COM and INIT2.COM.

III. **USING THE PSEUDO DISK**

After the PSEUDO DISK has been installed, it is accessed just like another disk drive, using the drive designation assigned to it (default = C:). Files can be transferred to and from it using standard file copy programs such as PIP.

In fact, a submit file can be used to:

1. Install the PSEUDO DISK.

2. Copy several files.

by using a single command.

FOR EXAMPLE, the following submit file, XFER.SUB, will install the PSEUDO DISK (Drive C:) and then copy files from Drive B to it simply by typing, SUBMIT XFER.

```
-----------------------------------------------------------------
file XFER.SUB:
                            INIT
                            PIP C:=B:*.*
-----------------------------------------------------------------
```

IV. **LIMITATIONS AND REQUIREMENTS**

1. The CP/M PSEUDO DISK will utilize up to 256K of RAM in the form of SATURN 32K, 64K, or 128K RAM Boards as well as 16K RAM Boards.

2. The PSEUDO DISK driver routines reside in the portion of the I/O configuration block reserved for user I/O Driver Software. As a result, this space is unavailable for user drivers after the PSEUDO DISK has been installed.

Chapter 9

TECHNICAL INFORMATION

I. ADDRESSING THE SATURN 64K AND 128K RAM BOARDS

The Saturn 64K RAM board contains 64K bytes(and the 128K RAM board, 128K bytes) of RAM memory, divided into 16K byte banks. These banks are selected independently of each other, and in many respects appear as four 16K RAM boards (for the 64K RAM board) or eight 16K RAM boards (for the Saturn 128K board) occupying a single slot.

All of the 16K banks occupy the same memory space as the Apple main board ROMS, from $DOOO to $FFFF. In this respect, they share the same memory space as the ROMS. At any given time, either the main board ROMS are accessed, or one of the 16K banks, but not both. Since the ROM space from $DOOO to $FFFF is only 12K long, and each bank on the Saturn RAM board is 16K bytes in size, only 12K each of these banks can be accessed at any given time. This is because the 4K memory space from $COOO to $CFFF is used by the Apple II for I/O and cannot be shared by the RAM on the Saturn 64K or 128K boards.

In order to access the full 16K bytes of each bank on the Saturn board, the lower 4K of the RAM board address space is used twice. Each 16K bank of the Saturn RAM board is divided into two 4K banks occupying the memory space from $DOOO to $DFFF, and one 8K block from $EOOO to $FFFF. Within a given 16K bank, one may select either of the two 4K banks to occupy the space from $DOOO to $DFFF.

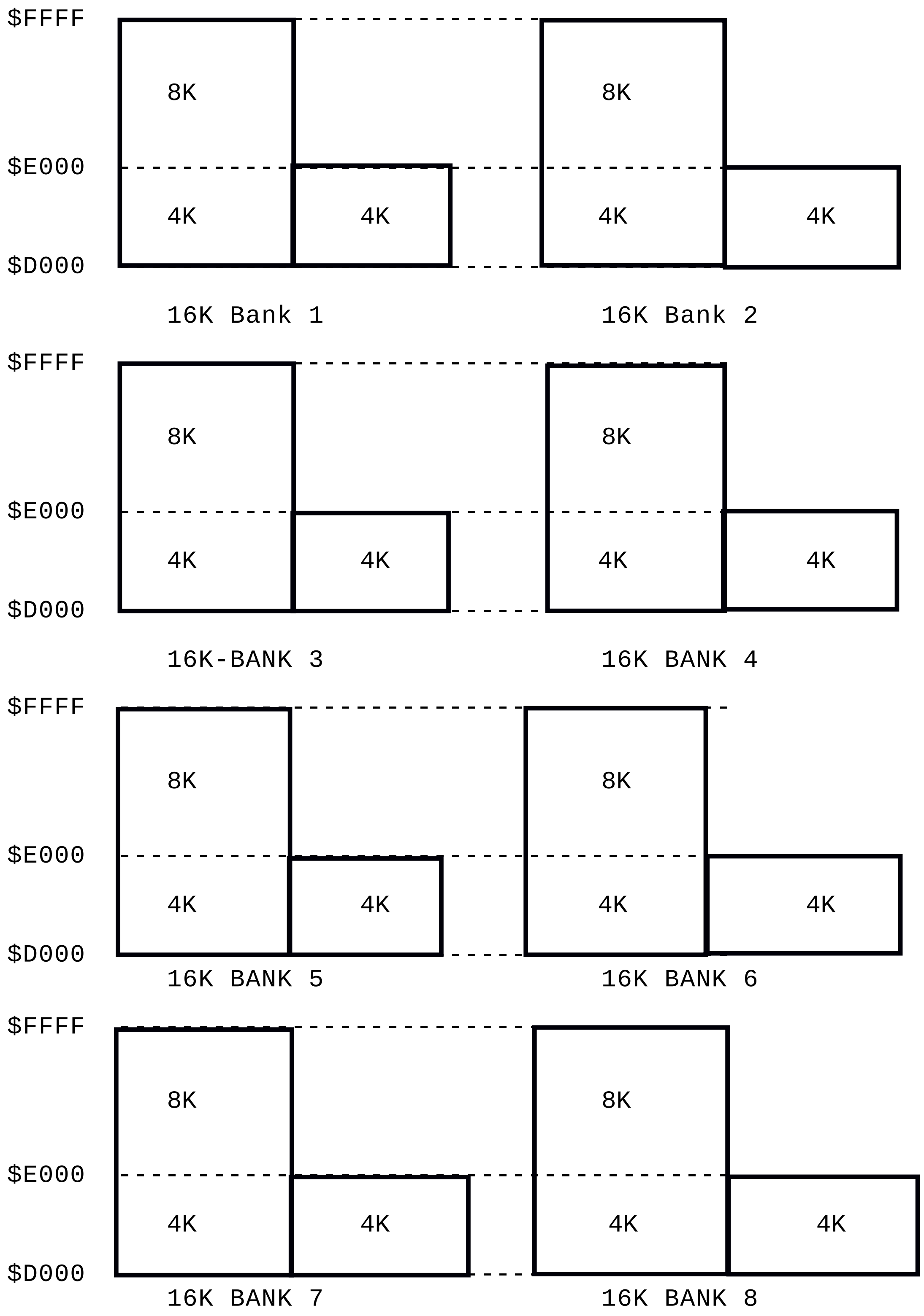
One has access to the full 64K on the Saturn 64K board (128K on the Saturn 128K board) by selecting it in 12K segments. To define a given segment, two things must be designated.

1. The 16K bank to be accessed.
2. The 4K bank to be used within this 16K bank.

The following convention has been established to describe the Saturn 64K board. The four 16K banks are denoted 16K Bank 1, 16K Bank 2, 16K Bank 3 and 16K Bank 4. Within each 16K bank, the 4K banks are described as 4K Bank A and 4K Bank B. In order to distinguish the 4K banks within 16K Bank 1 from those in 16K Bank 2, 16K Bank 3 or 16K Bank 4, the 4K bank designation is preceded by 1, 2, 3 or 4, indicating the 16K bank to which it belongs. Thus, 4K Bank lA describes the first 4K bank within 16K Bank 1.

The Saturn 128K RAM board is described in the same manner as the 64K board, with the exception that it contains eight 16K banks, rather than 4. These banks are denoted 16K Bank 1 through 16K Bank 8.

The following memory map depicts schematically the Banks present on the 128K RAM board. Only the first 4 16K banks displayed are present on the 64K board.



II. <u>CONTROLLING THE SATURN 64K and 128K RAM BOARD</u>

The Saturn 64K and 128K boards are controlled using 16 locations in the range $CONO – $CONF, where N = 8 + Saturn board slot #. Thus for slot zero operation, the control addresses are in the range $C080 to $C08F. These locations are in the Apple's peripheral I/O space as described in Apple II reference manual, p. 80. They are used by the Saturn 64K and 128K boards to control the following functions:

1. Select the Saturn RAM board or the Apple main board ROM.
2. Select the desired 16K bank to access.
3. Determine which 4K bank (A or B) within each 16K bank is to be used.
4. Write enable or write protect RAM.

In order to set the Saturn 64K or 128K board in a given state, a memory access to the particular location corresponding to the desired state is all that is required. This can be accomplished by either reading or writing to the location. From BASIC, a POKE or PEEK will accomplish this memory access. A machine language load or store will also serve the same purpose.

The lower 4 bits of the control address selects the mode of operation of the Saturn 64K and 128K boards, as well as determines which 16K bank is to be accessed.

A. When address line 2 is low (A2=0) state selection is enabled. In this case address lines 0, 1 and 3 determine the state which is set as follows.

1. Address line 0 determines whether the board will be write enabled or write protected. (AO = 0 for write protect; AO = 1 for write enable)

2. Address lines 0 and 1 are used to determine whether the main board ROMs are accessed, or the RAM on the Saturn board.

3. Address line 3 determines which 4K bank within the selected 16K bank to use. (A3 = 0 for 4K bank A; A3 = 1 for 4K bank B)

B. On the other hand when address line 2 is high (A2=l) 16K Bank selection is enabled. The address lines 0, 1 and 3 determine which 16K bank is selected.

The following table summarizes the various mode combinations which are available.

Control Address	Function
$C0N0	4K Bank A; RAM read; Write protect
$C0Nl	4K Bank A; ROM read; Write enabled
$C0N2	4K Bank A; ROM read; Write protect *
$C0N3	4K Bank A; RAM read; Write enabled
$C0N8	4K Bank B; RAM read; Write protect
$C0N9	4K Bank B; ROM read; Write enabled
$C0NA	4K Bank B; ROM read; Write protect *
$C0NB	4K Bank B; RAM read; Write enabled
$C0N4	select 16K Bank 1
$C0N5	select 16K Bank 2
$C0N6	select 16K Bank 3
$C0N7	select 16K Bank 4
$C0NC	select 16K Bank 5
$C0ND	select 16K Bank 6
$C0NE	select 16K Bank 7
$C0NF	select 16K Bank 8

Notes:

N = 8 + Saturn 32K board slot # (for slot 0, N=8).

16K Bank 1 = 1st 16K bank of Saturn RAM board
16K Bank 2 = 2nd 16K bank of Saturn RAM board

4K Bank lA = 1st 4K bank of the selected 16K Bank
4K Bank lB = 2nd 4K bank of the selected 16K Bank

ROM read:	The RAM on the Saturn board is disabled for reading and the main board ROM enabled.
RAM read:	The RAM on the Saturn board is enabled for reading.
Write enable:	The RAM on the Saturn RAM board is enabled for writing.
Write protect:	Data cannot be written to the RAM on the Saturn Board.

* This combination (ROM read and RAM write protect) effectively disables the Saturn 64K or 128K board. The board is in this state and Bank 1 is selected upon power up.

Using the appropriate mode combination (previous table), any given byte of memory on the Saturn RAM board can be accessed. In fact, in several modes (CON1, CON9) the main board ROM’s are accessed during a read from $DOOO – $FFFF, whereas the RAM on the Saturn RAM board is written to during a write operation. This enables one to write to the RAM while running BASIC in ROM which occupies the same address space. This is possible since BASIC is being read from ROM while the program may in fact be writing to RAM (via POKES).

Note Concerning Write Enabling the RAM:

In order to enable the Saturn 64K or 128K RAM board for writing to RAM, the corresponding control address (for mode desired) must be accessed twice. This is required for any of the write enable modes. If the board is already in a write enabled state (e.g. $CONl), and another mode is desired which is write enabled as well (e.g. $CON3), then only one access to the control address corresponding to this new mode is required. If on the other hand, the board is in a write protected state (e.g. C0N0) prior to the change, two access to the control address are required to write enable the board.

III. **SATURN 64K and 128K RAM BOARD MEMORY USE**

A. RELOCATED DOS

The relocated DOS occupies 16K Bank 2 and 4K Bank 2A, using the full 12K of memory space from $DOOO – $FFFF, for DOS, monitor routines and associated file buffers. This bank is enabled using control address $CON3 and Bank select address $CON5. The 4K Bank 2B is not used by the relocated DOS.

B. ALTERNATE BASIC

When the alternate BASIC (INTEGER for an Apple II plus; Applesoft for an Apple II) is present in the Saturn RAM board, it occupies 16K Bank 1 and 4K Bank lA, and is enabled for reading using control address $CONO and bank select $CON4. The 4K Bank lB is not used by this BASIC.

C. LED INDICATORS:

The Saturn 64K and 128K RAM boards contain 4 light emitting diodes (LEDs) which provide some visual indication of the state of the card. Three of the LEDs indicate which bank is selected and the fourth whether the board is read enabled (RAM READ state)

The LEDs are defined as follows (left to right when board is oriented face up, with LEDs a the top of the board), A3, Al, AO, RAM READ. When the board is read enabled ($CONO, $CON3, $CONS, $CONB) the RAM READ LED is "on"

There are 16 possible states for the LEDS:

BANK, STATE	A3	Al	A0
16K bank 1, ROM READ	off	off	off
16K bank 2, ROM READ	off	off	on
16K bank 3, ROM READ	off	on	off
16K bank 4, ROM READ	off	on	on
16K bank 5, ROM READ	on	off	off
16K bank 6, ROM READ	on	off	on
16K bank 7, ROM READ	on	on	off
16K bank 8, ROM READ	on	on	on
16K bank 1, RAM READ	off	off	off
16K bank 2, RAM READ	off	off	on
16K bank 3, RAM READ	off	on	off
16K bank 4, RAM READ	off	on	on
16K bank 5, RAM READ	on	off	off
16K bank 6, RAM READ	on	off	on
16K bank 7, RAM READ	on	on	off
16K bank 8, RAM READ	on	on	on

D. DIAGNOSTIC PROGRAMS:

A memory test/diagnostic program is provided with the Saturn 64K and 128K RAM boards. The program RAMTEST64K is used for testing the memory on a Saturn 64K board, and the program RAMTEST128K is used for testing a Saturn 128K board. Program operation is identical in both versions.

1. BRUN the appropriate RAMTEST program.

2. The program will ask for the slot number to test. Respond with the slot # of the RAM board to be tested.

3. If an extensive memory test, including refresh tests, is desired follow the slot * with a “F”.

for example, if the RAM board is in slot 0, then enter:

OF<CR>

to start the test.

4. The diagnostic test will run for several minutes, and upon successful completion will display the prompt line:

ENTER SLOT NUMBERS TO TEST:

IV. **SPECIFICATIONS**

A. Memory

Type:	dynamic
Access time:	200ns
Refresh:	7 bit

B. Power consumption (average)

+5V	l6Oma

C. Compatible Parts

Motorola
Fugitsu
NEC
Hitachi
Oki

SATURN RAM BOARD WARRANTY

Saturn Systems, Inc. (551) warrants this product to be free of defects in material and workmanship for a period of one (1) year from the original date of purchase to the original user only. During this period, 551 will repair (or, at its option, replace) this product free of charge, provided that it is returned with dated proof of purchase to Saturn Systems, Inc., 3990 Varsity Dr., Ann Arbor, MI 48104. This warranty does not apply, if in the opinion of SSI, the product has been damaged by accident, misuse, neglect or misapplication as a result of service or modification by other than Saturn Systems.

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