MICROSOFT® RAMCARD™

Memory Board

For Apple® II

Microsoft™ RAMCard™

Memory Board

for the Apple® II Computer

Operator's Manual

Microsoft Corporation

The RAMCard memory board was designed and written for Microsoft Corporation by Burtronix of Villa Park, California.

Microsoft Corporation
Microsoft Building
10700 Northup Way
C-97200
Bellevue, Washington 98004

Catalog no. 2313
Part no. 23F13
Document no. 8803-100-01

Contents

Chapter 1
Introduction

The RAMCard™ memory board is a printed circuit board that provides 16K bytes of additional random-access memory (RAM) for your Apple® II computer or Apple® II Plus computer. (One K byte equals 1024 bytes.)

RAMCard is designed for an Apple II computer with 48K bytes of RAM already in place. If your Apple II computer has less than 48K RAM, you will need to purchase enough 16K memory modules to bring your Apple II up to 48K.

RAMCard is compatible with the Microsoft™ SoftCard™ system, a circuit board for the Apple II computer which contains a Z80® microprocessor and allows you to run the CP/M operating system (included in the SoftCard package). RAMCard and SoftCard together make a powerful combination that turns your Apple II computer into a flexible microcomputer with 60K of memory and two microprocessors.

With RAMCard and SoftCard in place, you have 60K of RAM available to run any of the languages available for the SoftCard, including Microsoft™ BASIC Interpreter (included in the SoftCard package), Microsoft™ COBOL Compiler , Microsoft™ FORTRAN Compiler (1966 standard), Microsoft™ BASIC Compiler, and Assembly Language Development System™.

RAMCard contains 16K of memory. But, because only 12K of additional addressing space is available in the Apple, 4K of addressing space must be shared by two 4K memory banks. This means that only 12K of RAMCard RAM is available to you at a given time.

Note for Apple® DOS 3.2 and 13-Sector CP/M Users

Apple II computers come standard with one of two BASICs: Applesoft or Integer BASIC. Standard Apple II systems have Integer BASIC, and Apple II Plus systems have Applesoft.

If you have installed an Apple® Firmware Card in Slot 0, to use the other version of BASIC, you must remove it when RAMCard is installed. This means that the BASIC on the Apple Firmware Card will no longer be available.

To use RAMCard with the Microsoft SoftCard circuit board and CP/M, you must have a 16-sector system. This is because you must use the CPM60 program to update your CP/M system to 60K. The CPM60 utility is included *only* on your SoftCard Master floppy disk. In addition, most of the other software available for RAMCard also requires a 16-sector floppy disk drive system.

These problems can be solved with Apple® computer DOS 3.3 16-sector update kit, available through your Apple dealer. This package contains software that will allow you to load the other version of BASIC into RAMCard, so that both versions of BASIC will be available for use by Apple DOS programs. A floppy disk is also supplied with the DOS 3.3 package that will allow you to boot your old 13-sector floppy disks.

Chapter 2
Installation Instructions

This chapter gives step by step instructions for installing the RAMCard memory board.

We recommend that you read all the instructions first to acquaint yourself with the overall procedure. Then, perform each step with care, exactly as described.

Opening Your Apple II

Since RAMCard is to be installed *inside* your Apple II, you must remove the cover of your Apple II before you start.

Warning

It is dangerous to open any electrical or electronic device with the power on. Additionally, attempting to insert or remove peripheral boards while your Apple II computer power is on will probably damage the boards and other parts of your Apple II. Be sure to turn off the power to your Apple II before performing any of the steps in this procedure.

---

1. Turn off the power.

   The POWER light on the lower left corner of the keyboard should not be illuminated.

2. Remove the cover from your Apple II computer.

   Pull up on the rear edge of the cover until the fasteners at the rear corners pop apart. Do this firmly enough to separate the fasteners, then stop. Do not pull up any further.

3. Slide the cover backward.

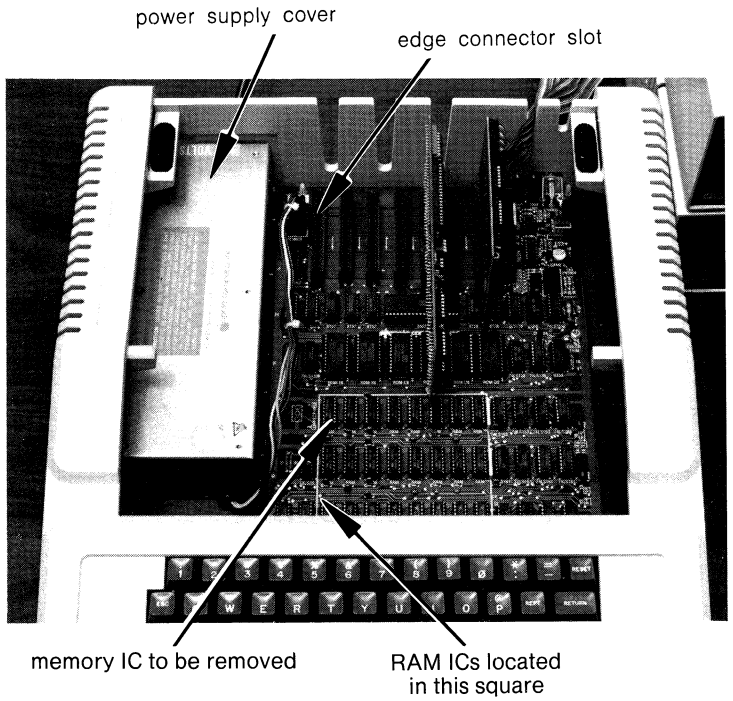
   Slide the cover away from the keyboard towards the rear of your Apple II. The interior of your Apple II should now be exposed.

Removing a Memory IC

Before you can install RAMCard, you must remove one of the memory ICs (Integrated Circuits) inside your Apple II. You will insert the plug on the RAMCard connector cable into the space where the IC is now.

1. Look into your Apple II.

   Familiarize yourself with the inside.



The Interior of an Apple II

You should see:

A big silver- or gold-colored box (the power supply cover) along the left side.

Eight long, narrow slots (edge-connector receptacles), green or black outside with gold-plated contacts inside, located perpendicular to and against the back wall of the Apple II chassis. The slots are numbered 0 to 7, from left to right. The numbers are located between the far end of the slots and the chassis back wall.

A 4-inch by 4-inch square outlined in white, located directly behind the keyboard (RAM ICs are located here).

2. Touch the power-supply cover.

   Touch the cover to discharge any static electricity you may be carrying.

3. Find Slot 0.

   Lean over your Apple II to see the numbers at the far end (back of the chassis) of the eight slots. They are numbered 0 to 7, from left to right. You want the number 0 slot, the first on the left.

4. Remove board from Slot 0.

   Slot 0 is the slot you will use for RAMCard. If there is a board in Slot 0, it must be removed. If there is no board in Slot 0, disregard this step and go on to step 5.

5. Find the left rear memory IC.

   Look inside the white square. There are three rows of eight memory ICs installed within the square. Locate the IC in the last row (farthest from the keyboard) and the first column (farthest left, closest to the power-supply cover). This is the IC you will remove.

6. Remove the left rear memory IC.

Removing the Memory IC

Important

Touch the power-supply cover to discharge static electricity on your body before grasping the IC.

Warning

Remove the memory IC carefully. Be sure you do not damage the IC or the circuit board sockets in any way. Avoid touching the pins on the IC with your fingers because static electricity on your body may damage the IC. Grasp the IC by the ends with the IC extractor only.

Use the IC extractor (which resembles a large pair of tweezers and is included in the RAMCard package) to grasp the IC at each end. There is a slot under the IC at each end where the extractor prongs will fit. Wiggle the IC very slightly to loosen it. Apply no more upward or lateral force than necessary to remove the IC so that the IC will not be damaged.

You are now ready to insert RAMCard into your Apple II.

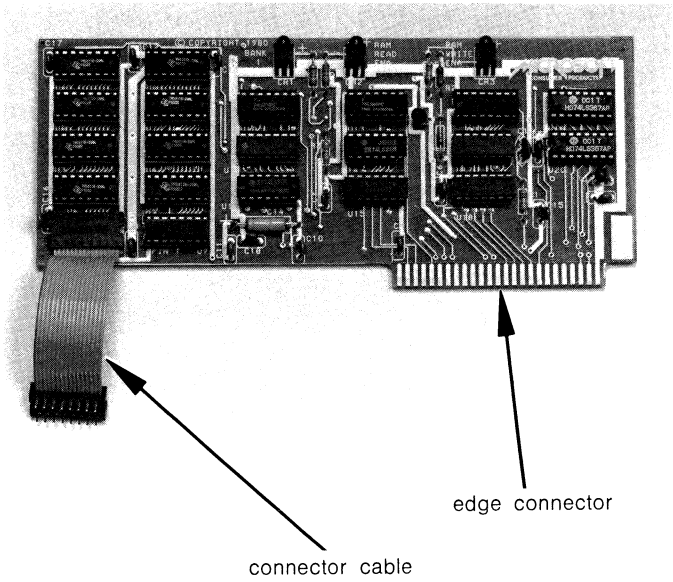
Inserting RAMCard Memory Board into Place

Inserting RAMCard is actually two separate procedures. First, you insert the plug at the end of the connector cable into the socket left empty when you removed the IC. Then, insert the board itself into Slot 0.

Inserting the Plug

1. Examine RAMCard.

   Set the board in front of you, face up.



RAMCard

   Notice the connector cable at the bottom left corner of the board. One edge of the cable is colored differently from the rest of the cable. At the end of the cable is a plug. The cable plug will go into the vacant memory IC space inside your Apple II. Notice that RAMCard also has an I/O connector strip along one edge. The edge-connector will go into Slot 0.

2. Position the RAMCard memory board and plug.

   Hold the board by its edges, over the Apple II so that the cable end is toward the keyboard, the side with the ICs is facing to your right, and the edge-connector is positioned over Slot 0.

3. Insert the plug.

Inserting the RAMCard Cable

Position the pins on the cable plug directly over the holes from where the memory IC was removed. *Gently* apply pressure to the top of the plug. Apply only enough pressure to seat the plug completely.

If the plug does not slide into the holes easily, remove it, reposition the pins, then apply gentle pressure until the plug is seated. A very slight wiggle may be used to help seat the plug. But any lateral movement may damage a pin so avoid wiggling if possible. If you must wiggle the plug to seat it fully, be sure the pins are lined up properly first, then wiggle only very slightly and very slowly.

Inserting RAMCard

1. Position RAMCard over Slot 0.

   Hold the RAMCard memory board so that it can be inserted in Slot 0 without twisting the cable. If the board cannot be inserted without twisting the connector cable, the plug was inserted backwards. Remove the plug and reinsert it so the connector cable will not be twisted when RAMCard is inserted.

2. Position the edge-connector into Slot 0.

Inserting the RAMCard Memory Board into Slot 0

Set the RAMCard edge-connector into Slot 0. Be sure that the connector on the board is centered in the slot.

3. Press the RAMCard memory board into place.

   Do not wiggle RAMCard from side to side! If necessary, you can wiggle the board lengthwise, from back to front, to help seat the board into Slot 0 completely.

4. Recheck seating of plug and board.

   Be sure that both the plug and the board are fully seated.

5. Replace cover.

   When you are satisfied that the plug and board are correctly installed (you may want to reread the instructions), slide the cover of your Apple II toward the keyboard. When the cover is in place, press down on the rear corners of the cover until the fasteners snap closed.

6. Power up.

   Your Apple II is now ready to run. You can switch on the power and bring up CP/M if you have the SoftCard. With SoftCard installed, you now have 60K contiguous RAM available to run 60K CP/M. You can create 60K CP/M system disks with the CPM60 utility included with your SoftCard package. For instructions on using SoftCard and RAMCard together, refer to "Using SoftCard CP/M with the Apple Language Card" in Chapter 3, *Microsoft SoftCard Installation and Operation Manual.* For each reference to the Apple Language Card, simply substitute RAMCard.

   Other software can also be used with RAMCard. See Chapter 3 for more information.

Chapter 3
Using RAMCard

For some Apple II configurations, installing RAMCard memory board will change the procedures you used in running your existing software.

This chapter outlines which configurations of the Apple II are affected by the RAMCard memory board and what software procedures you need to change. This chapter also lists some of the software that is compatible with RAMCard.

How to Use Your Existing Software

Installing RAMCard in your Apple II will affect the operation of your existing software if:

1. You are using an Apple Firmware Card in Slot 0.
2. You are using 13-sector disks with SoftCard and CP/M.

Both conditions are described in the following paragraphs.

Using an Apple Firmware Card

Apple II computers come standard with one of two BASICs: Applesoft or Integer BASIC. Standard Apple II systems use Integer BASIC, and Apple II Plus systems use Applesoft.

If you have installed an Apple Firmware Card in Slot 0 to make available the other version of BASIC, you must remove it when RAMCard is installed. This means that the BASIC on the Apple Firmware Card will no longer be available. When you lose the BASIC on the Apple Firmware Card, you also lose access to any programs you may have that are written in that BASIC.

Using 13-Sector Disks With SoftCard and CP/M

If you are using CP/M (and SoftCard), then you must use the CPM60 utility to take advantage of RAMCard additional memory. The CPM60 utility is found only on the 16-sector SoftCard CP/M Master disk in the SoftCard package.

Refer to "CPM60" in Chapter 5, *Microsoft SoftCard Installation and Operation Manual,* for instructions on using the CPM60 utility. Most of the other software that takes advantage of RAMCard memory, such as Apple® FORTRAN, is supplied on 16-sector disks only. To use this software, you will need a 16-sector disk system.

If you are using a 13-sector system and want to use the software available only on 16-sector disks, you must update to a 16-sector system.

To take advantage of the additional RAMCard memory and still be able to use the Applesoft or Integer BASICs, update your system to Apple DOS 3.3. Then, you will have both BASICs on disks, and you can load the "other" BASIC into RAMCard. By updating, you will again have access to the programs you wrote in the BASIC on your Apple Firmware Card.

Updating to Apple DOS 3.3 also allows you to boot 13-sector disks, and allows you to use 16-sector CP/M (and hence 60K of memory).

Compatible Software

RAMCard is compatible with all the software that can be used with the Apple Language Card. In fact, RAMCard is very similar to the Apple Language Card, with one exception: RAMCard does not have Autostart ROM. (See more on Autostart ROM below.)

If you wish, you need only refer to the instructions in the software product documentation for using that software with the Apple Language Card. The instructions will also be applicable to the RAMCard.

Some of the software packages that can be used with RAMCard are:

CP/M, which also allows you to use:

- Microsoft COBOL Compiler
- Microsoft FORTRAN Compiler
- Microsoft BASIC Compiler
- Microsoft Assembly Language Development System™
- Multiplan™ electronic worksheet

Or under Apple DOS:

- Applesoft BASIC
- Integer BASIC
- Apple® Pascal system
- Apple® FORTRAN
- Apple® PILOT

Autostart ROM

RAMCard does not include Autostart ROM. In a few cases, this may affect use of software designed to be used with the Apple Language Card. In addition, unless your Apple II has Autostart ROM installed onboard, the convenient auto-boot features of Autostart ROM are not available. In order to behave exactly as if a Language Card is installed, some software may require Autostart ROM.

If you have an Apple II Plus, your computer has Autostart ROM installed onboard. If you have an Apple II, you may want to install the Autostart ROM to take advantage of the auto-boot features.

Chapter 4
Addressing RAMCard

The information in this chapter is highly technical and is intended as reference material only.

This chapter describes the addressing of RAMCard. It includes memory maps showing the addresses used for RAMCard RAM and Apple onboard ROM, and a description of the control addresses and their functions. At the end of the chapter, some additional technical details relating to RAMCard and Apple II hardware are described.

RAMCard contains 16K of memory. But, because the memory addresses $C000 through $CFFF are used for the Apple I/O, only the 12K of space from $D000 to $FFFF is available to address the 16K of RAMCard. To address all of the 16K of memory on RAMCard, the lower 4K of RAMCard address space is used twice. The programmer can select either of two 4K memory banks to occupy the space from $D000 to $DFFF at one time. This allows 8K of memory to be accessed in only 4K of address space.

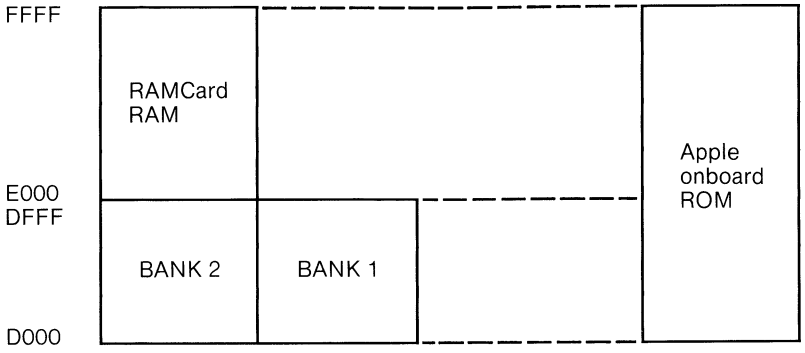
Also, RAMCard shares this memory space with the onboard Apple ROMs.

The programmer can, therefore, choose whether the memory addresses between $D000 and $FFFF will be used to read ROM or read RAMCard RAM, and whether these same addresses will be write-enabled or write-protected for RAMCard RAM. The selection of these functions, plus the selection of which 4K memory bank will be used, are performed by accesses to control addresses.

Addressing information is divided into three sections in this chapter. The first section shows memory maps. The maps show the memory addresses for the functions called through control addresses. The second section describes these control addresses, which provide memory mode selection, RAM write-enable/-protect, and bank switching. The third section describes additional technical details about status bits, the LED indicators on RAMCard, and RAMCard hardware details.

Memory Maps

The following diagram illustrates the range of addresses used for the memory functions of RAMCard and the Apple onboard ROM.



Control Addresses

The control addresses are special memory addresses that, when accessed, simultaneously control three unrelated functions:

1. Selection of write-protect or write-enable RAMCard RAM.
2. Selection of RAMCard RAM read or Apple II onboard ROM.
3. Selection of which 4K bank will be mapped into the $D000—$DFFF addressing space.

   Because the address space $C000—$CFFF is used by Apple II, only 12K ($D000—$FFFF) of address space is available for 16K RAM. Using the control addresses to switch between the two 4K banks allows you to address 8K RAM with only 4K of address space.

   The remainder of the RAMCard RAM ($E000—$FFFF) is directly addressable.

Control addresses are entered in hexadecimal for assembly language programs, or in decimal for BASIC programs. Hexadecimal addresses begin with the dollar sign ($).

All of the hexadecimal control addresses have the form $C08x. x is any of the hexadecimal digits 0-3,8-9,A-B. The value of x determines which bank and which functions are selected. When the value of x is converted to binary, then the functions associated with the bit positions can be seen more clearly.

The hexadecimal digits 0-3,8-9,A-B convert to binary as follows:

Hex	Binary		
0	0	0	00
1	0	0	01
2	0	0	10
3	0	0	11
8	1	0	00
9	1	0	01
A	1	0	10
B	1	0	11

Bits 0 and 1 (the two right columns of each binary number) are read together to select the functions. As you can see there are only four selections—00, 01, 10, 11. These selections are repeated.

Bits 0 and 1 together select the following functions:

00 Selects RAMCard RAM read and RAM write-protect.

01 Selects onboard ROM read. Two or more successive reads to the address write-enables RAMCard RAM.

10 Selects onboard ROM read and write-protects RAM.

11 Selects RAMCard RAM read. Two or more successive reads to the address write-enables RAM.

When ROM is selected, the Apple II onboard ROM is selected for the address space $D000—$FFFF. Refer back to "Memory Maps" for an illustration of these relationships.

Notice that it is possible to write to the RAMCard RAM and read from the onboard ROMs at the same time (01 above).

Bit 2 (the third column from the right in each binary number) is ignored.

Bit 3 (the left column in each binary number) selects which 4K bank will be accessible. If bit 3 is zero (x is between $0—$3), then BANK 2 will be mapped into D000—$DFFF. If bit 3 is one (x is between $8—$B), then BANK 1 will be mapped into $D000—$DFFF. When one bank is selected, the other bank is not available.

The Power-on/Reset sequence selects onboard ROM read (disables RAMCard RAM read), write-enables RAMCard RAM, and selects mapping of BANK 2 in the address space $D000—$DFFF. This is identical to two consecutive accesses of $C081.

The various selections are summarized in the chart below. Both the hexadecimal and decimal control addresses are shown in the first column.

Control Address	Last Digit (Binary)	Functions/Bank Selected
$C080 —16256	0000	Selects RAMCard RAM read, BANK 2, and RAM write-protect.
$C081 —16255	0001	Selects Apple onboard ROM read, BANK 2, and write-enables RAMCard RAM if address is accessed twice consecutively.
$C082 —16254	0010	Selects Apple onboard ROM read, BANK 2, and RAMCard RAM write-protect.
$C083 —16253	0011	Selects RAMCard RAM read, BANK 2, and write-enables RAMCard RAM if address is accessed twice consecutively.
$C088 —16248	1000	Selects RAMCard RAM read, BANK 1, and RAMCard RAM write-protect.
$C089 —16247	1001	Selects Apple onboard ROM read, BANK 1, and write-enables RAMCard RAM if address is accessed twice consecutively.
$C08A —16246	1010	Selects Apple onboard ROM read, BANK 1, and RAMCard RAM write-protect.
$C08B —16245	1011	Selects RAMCard RAM read, BANK 1, and write-enables RAMCard RAM if address is accessed twice consecutively.

Note

If RAMCard RAM is already in a write-enabled state, only a single access of a write-enable control address ($C081, $C083, $C089, $C08B) is necessary to remain in a write-enable state until a write-protect control address is accessed. (This state applies immediately following power-on and RESET.)

Additional Technical Details

The topics in these sections include status bits, the LED indicators on RAMCard, and RAMCard hardware details.

Status Bits

Whenever a read operation is performed to any of the control addresses which alter RAMCard functions, the lower four bits of data returned show the status *just prior* to the read operation.

The four status bits (not to be confused with the bits of the control addresses) indicate:

BANK SELECT — When BANK 1 is selected, status bit 0 will be high. When BANK 2 is selected, status bit 0 will be low. This state applies immediately following power-on and RESET.

READ ENABLE — When RAMCard RAM is read-enabled, status bit 1 will be high. When Apple onboard ROM is enabled, status bit 1 will be low. This state applies immediately following power-on and RESET. When RAMCard RAM is read-enabled, an INH signal generated by the ICs in sockets U12 and U13 disable the ROMs on the Apple motherboard.

WRITE ENABLE — When RAMCard RAM is write-enabled, status bit 2 will be high. The state applies immediately following power-on and RESET. When RAMCard RAM is write-protected, status bit 2 will be low.

Note

Write-enable remains on until a write-protect control address is accessed. Therefore, accesses to a write-enable control address subsequent to a write-enable will write to RAMCard RAM unless a write-protect access intervenes. This state applies immediately following power-on and RESET.

NEXT — To protect RAMCard RAM from accidental write-enable, two consecutive accesses to a write-enable control address are required. When the first access has been done, the NEXT flag is set, and status bit 3 is high. When the second access has been done and RAMCard RAM is write-enabled, the NEXT flag is turned off, and status bit 3 is low.

LED Indicators

Three LED indicators are attached to RAMCard along the top edge. Next to each LED is a label describing the functions that the LEDs signal. The three labels are BANK 1, RAM READ ENA, and RAM WRITE ENA. The LEDs indicate whether the bank or function is on (selected) or off (deselected). They do not indicate whether an access is occurring or not. The LEDs indicate the following:

LED	ON	OFF
BANK 1	4K BANK 1 selected	4K BANK 2 selected
RAM READ ENA	RAMCard RAM read selected	Apple II ROM selected
RAM WRITE ENA	RAMCard RAM write-enabled	RAMCard RAM write-protected

The LEDs may be on or off in any combination because the banks and functions may be selected in any combination. At power-on/RESET, RAM WRITE ENA LED is on; the other two LEDs are off.

RAMCard Hardware Details

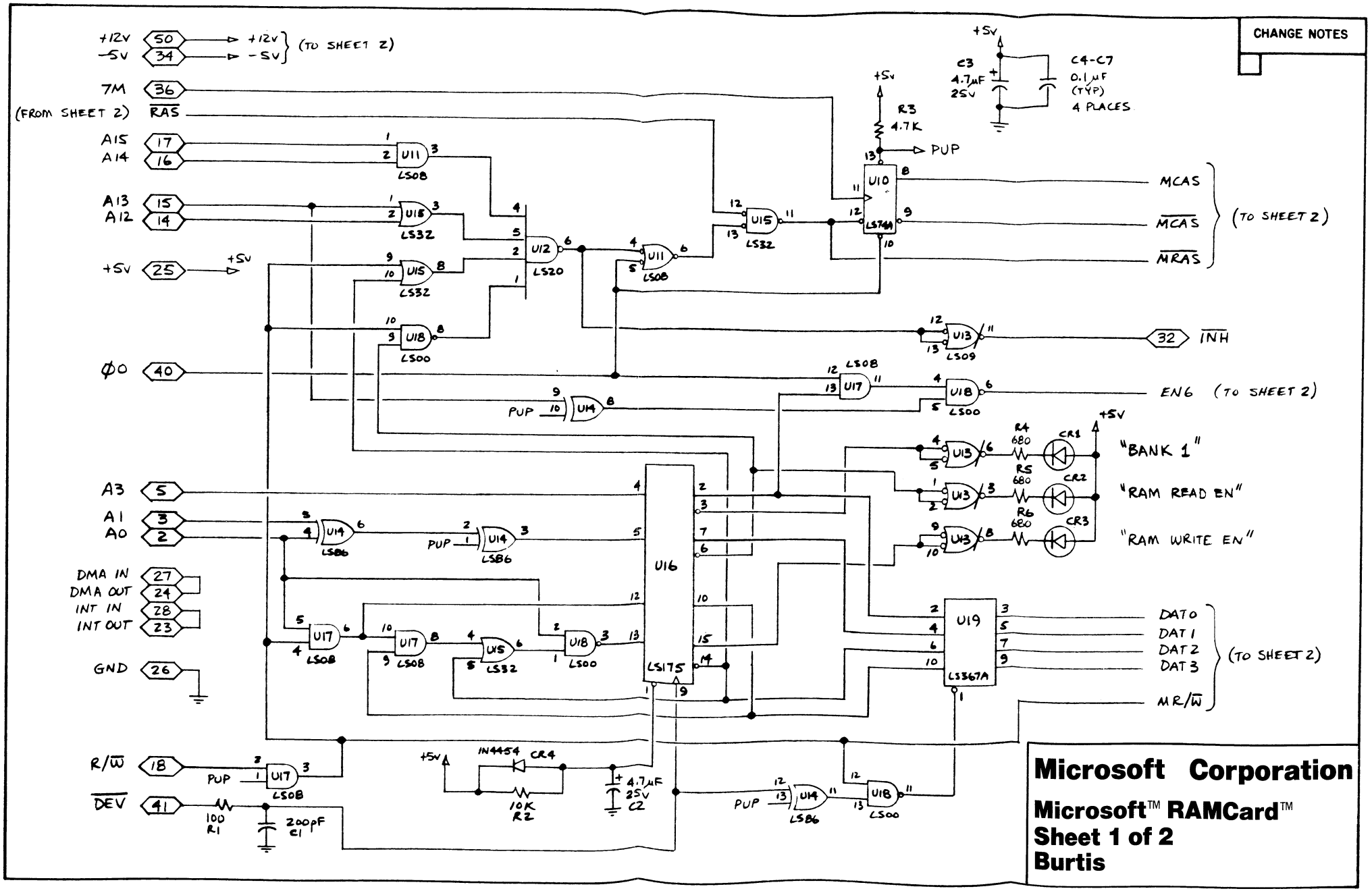
This section describes how the RAMCard memory board functions and indicates its status.

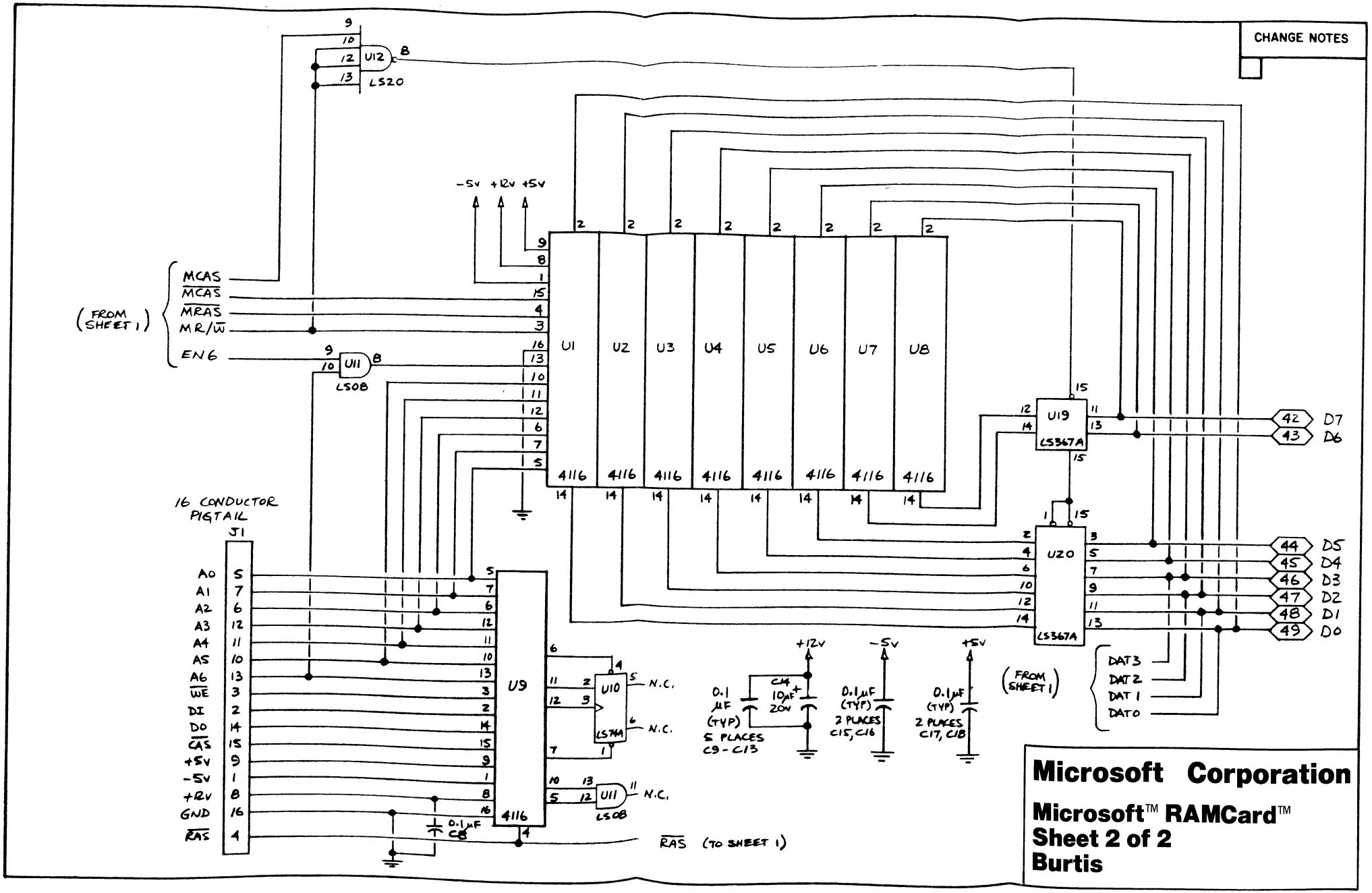
The connector cable provides the RAMCard memory ICs access to the multiplexed addresses and to a timing signal which is not available through the 50 pin I/O edge-connector.

Addresses for RAMCard memory ICs are provided by the Apple motherboard address multiplexer. Data in and out for the single displaced IC (which is inserted into socket U9 on RAMCard) are routed through the connector cable. Data in and out for the other eight ICs on RAMCard (in sockets U1—U8) are routed through the I/O edge-connector. The data out from the ICs in sockets U1—U8

are buffered on RAMCard (by the ICs in sockets U19 and U20) to ensure sufficient drive capability. Control addresses and status information are routed through the I/O edge-connector.

The decoding of the addresses and the storage of the state for each function are performed by the ICs in sockets U14—U18. The IC in socket U13 drives the LED indicators. Part of the IC in socket U19 buffers and selects the status bits during function selection. Once the state of each function is selected, the memory accesses on RAMCard are controlled by the ICs in sockets U11, U12, U15, and U18.


CHANGE NOTES
+12V
-5V
50
34
+12V
-5V
(TO SHEET 2)
7M
(FROM SHEET 2)
RAS
A15
A14
A13
A12
+5V
25
ϕ0
40
A3
5
A1
3
A0
2
DMA IN
DMA OUT
INT IN
INT OUT
27
24
28
23
GND
26
R/W
18
DEV
41
100
R1
200pF
C1
PUP
R3
4.7K
C3
4.7µF
25V
C4-C7
0.1µF
(TYP)
4 PLACES
U10
U11
U12
U13
U14
U15
U16
U17
U18
U19
LS08
LS32
LS20
LS00
LS09
LS86
LS74A
LS175
LS367A
MCAS
MCAS
MRAS
(TO SHEET 2)
32
INH
ENG
(TO SHEET 2)
R4
R5
R6
680
CR1
CR2
CR3
"BANK 1"
"RAM READ EN"
"RAM WRITE EN"
DAT0
DAT1
DAT2
DAT3
MR/W
(TO SHEET 2)
IN4454
CR4
10K
R2
4.7µF
25V
C2
Microsoft Corporation
Microsoft™ RAMCard™
Sheet 1 of 2
Burtis


CHANGE NOTES
U12
LS20
-5V +12V +5V
MCAS
MCAS
MRAS
MR/W
ENG
(FROM SHEET 1)
U11
LS08
U1 U2 U3 U4 U5 U6 U7 U8
4116
U19
LS367A
U20
LS367A
42 D7
43 D6
44 D5
45 D4
46 D3
47 D2
48 D1
49 D0
16 CONDUCTOR PIGTAIL
J1
A0 A1 A2 A3 A4 A5 A6 WE DI DO CAS +5V -5V +12V GND RAS
U9
4116
0.1µF C8
U10
LS74A
N.C.
N.C.
U11
LS08
N.C.
RAS (TO SHEET 1)
+12V
-5V
+5V
0.1 µF (TYP) 5 PLACES C9 - C13
C14 10µF+ 20V
0.1µF (TYP) 2 PLACES C15, C16
0.1µF (TYP) 2 PLACES C17, C18
(FROM SHEET 1)
DAT3
DAT2
DAT1
DAT0
Microsoft Corporation
Microsoft™ RAMCard™
Sheet 2 of 2
Burtis

Index

MICROSOFT®

MICROSOFT CORPORATION
10700 NORTHUP WAY
BELLEVUE, WASHINGTON 98004

Part No. 013-023-001