Apple Lisa Computer Technical Information

Apple Lisa 1 Computer Level 1 Technical Repair Procedures

Apple Lisa Computer
Technical Information
October 1988

Printed by: Macintosh Picture Printer 0.0.5 1999-01-11 Printed: 1999-03-04 18:59:02

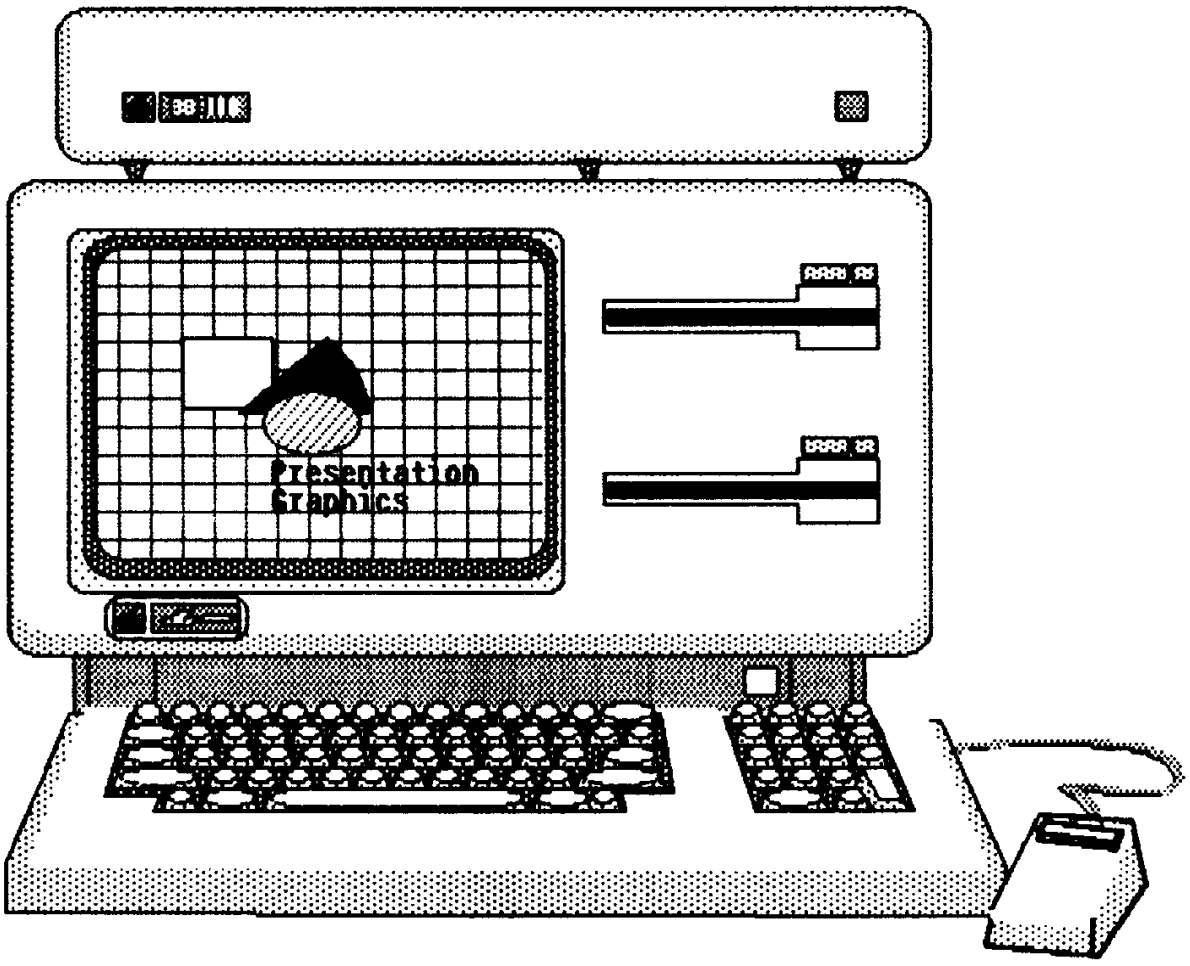
Lisa Level 1

Technical Procedures

#072-0085

Revision: October 1988

LISA



The Apple Lisa Technical Procedures document is divided into 2 parts:

- Lisa 1 technical procedures
- Lisa 2 technical procedures

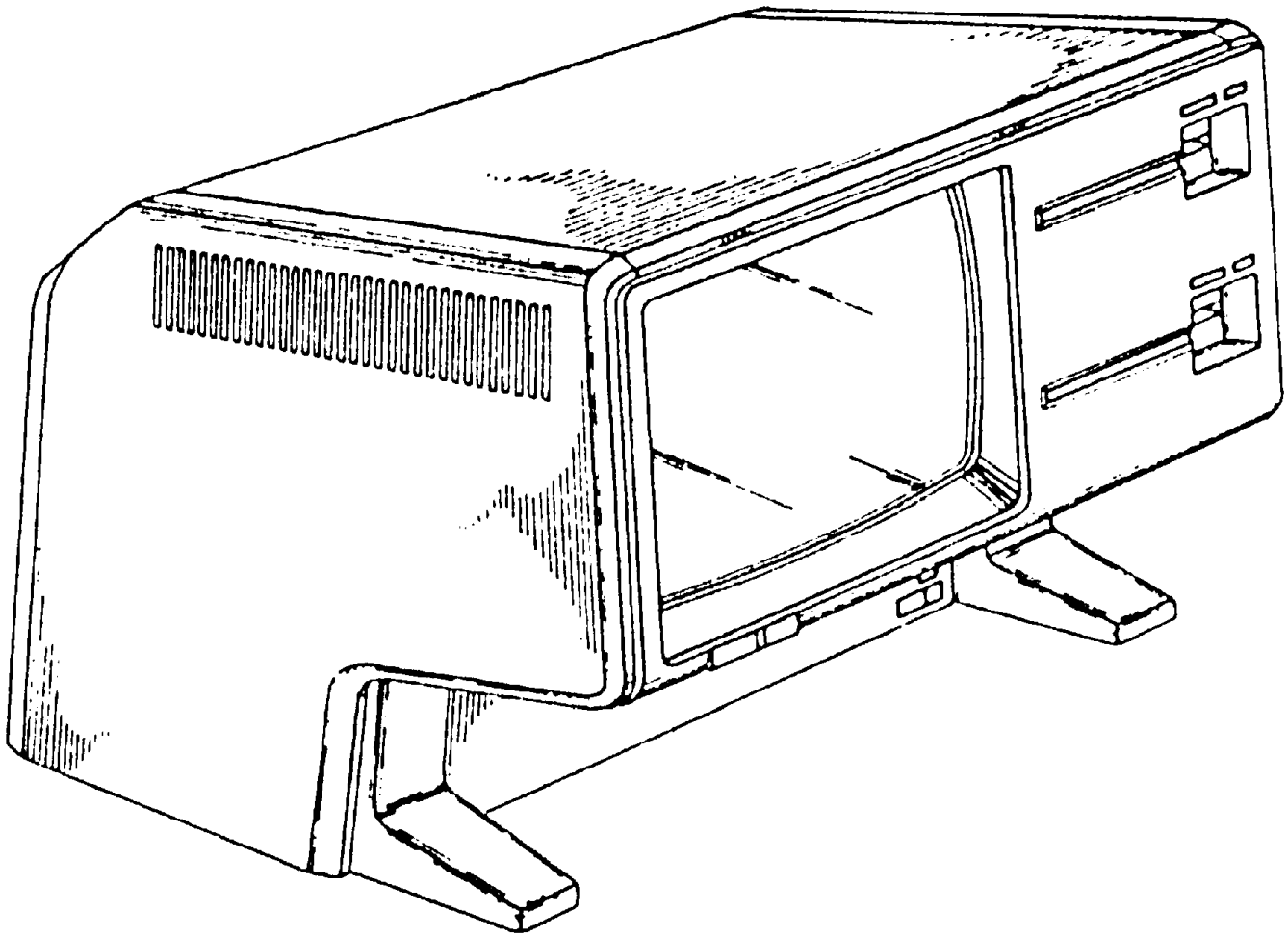
These parts have been scanned seperately since each is rather large.

Any sections from part 1 that are referenced by part 2 appear also in the part 2 scanned document.

The next page contains the total technical procedures table of contents.

The last part of this document (e.g. illustrated diagrams) appears in the part 2 scanned document.

DTC/Feb1999



LISA TECHNICAL PROCEDURES MANUAL

Volume Table of Contents

June 1986

LISA TECHNICAL PROCEDURES

TABLE OF CONTENTS

Section 1: Take-Apart

Section 2: Setup

Section 3: Video Take-apart

Section 4: Video Adjustments

Section 5: Diagnostics

apple computer

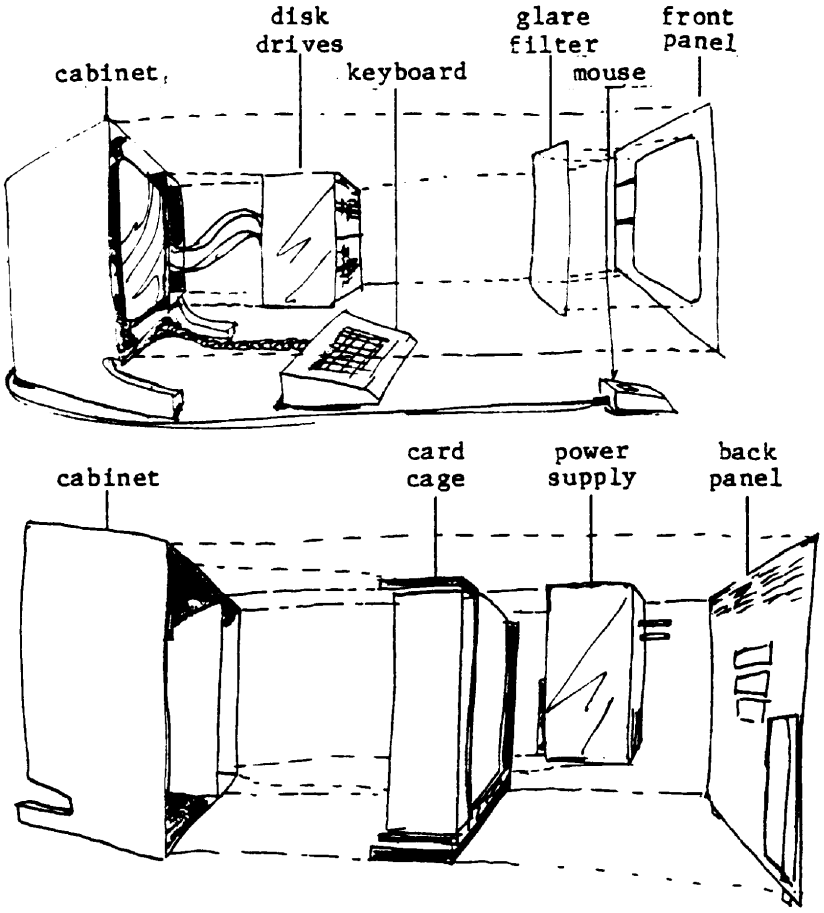
Lisa Technical Procedures

Section 1

Take-Apart

Contents:

apple computer



Lisa, Exploded View

apple computer

INTRODUCTION

Lisa has been designed so that users can do most of the servicing themselves, by removing and replacing faulty parts and by installing their own expansion cards. All the basic removal/replacement tasks are extremely easy, require no tools, and are described in the Service Section of the Lisa Owner's Guide. If you are new to Lisa service, use that section to guide you in taking a Lisa apart before you read further.

This section of the Technical Procedures contains take-apart procedures not found in the Owner's Guide, including removing a single disk drive from the set of two, retrieving a diskette from a malfunctioning drive, and transferring the Video State Machine ROM (6309 chip) from the old CPU board to the new board when replacing the CPU board.

apple computer

REPLACING THE DISK DRIVES

The disk drive assembly consists of the following components:

Drive carrier	P/N 805-4014
Drive carrier shelf	P/N 805-4013
Disk drives (2)	P/N 653-6110

The Drive carrier is the metal casing that holds the two drives. The carrier shelf is the metal shelf that supports the top drive. The upper and lower disk drives are identical.

To replace the bottom drive, remove the four Phillips screws on the underside of the assembly and slide the drive out. Simply slide the new drive in, screw it down, and reinsert the assembly into the Lisa.

To replace the top drive, remove the six Phillips screws that hold the carrier shelf in the middle of the assembly (three on each side). Grasp the drive by one of its metal ledges and slide drive and shelf out of the carrier. Then remove the four Phillips screws from the bottom of the carrier shelf and transfer the shelf to the new drive.

Test the new drives with the LisaTest disk test before returning the unit to the customer.

apple computer

REMOVING A DISKETTE FROM A MALFUNCTIONING DRIVE

If a drive malfunctions and locks onto a diskette, you will have to try to retrieve the diskette for the customer. Use the following method.

1. First, with the Lisa on, push the disk release button.

2. If the drive does not eject the diskette, turn the Lisa off; the diskette should be ejected as part of the power-down operations.

3. If the diskette is still stuck in the drive, turn off the Lisa and transfer the drives into a known-good Lisa. Then try pushing the disk release button and powering off.

If all these methods fail, you will have to force apart the jaws of the drive as follows:

1. Locate the black plastic arm attached to a spring (rear of drive, beneath the analog card).

2. Gently push down on the arm while pulling the diskette out the front of the drive. BE CAREFUL: Too much force will snap the arm right off.

apple computer

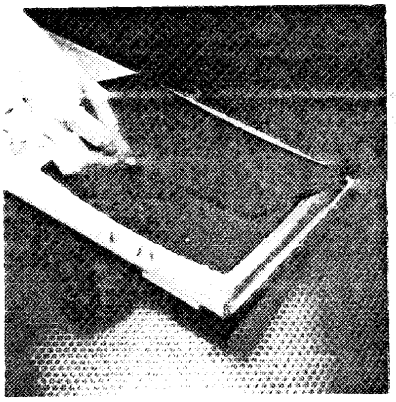
INSTALLING AND REMOVING THE GLARE FILTER

The glare filter is only needed when lighting conditions make the video screen hard to read. The glare filter will come with the Lisa accessories. You will not be expected to install it for the customer, but you should know how to install it, in case a customer needs help.

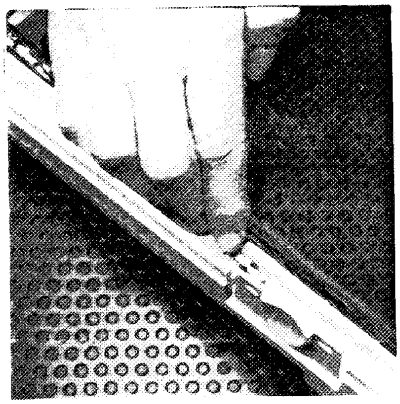
To Install:

1. Place the front panel of the Lisa face down on a flat surface.

2. Hold the glare filter so that the beveled side of the border is facing down. Place one long edge of the filter along the upper edge of the front panel, so that it slides under the small metal clip at the center of the frame.



3. Push the filter down so that it lies flat on the front panel, and flex the lower edge until it slides under the lower metal clip.



To Remove:

1. Push the frame of the glare filter out from under the metal clip at the bottom center of the frame.

2. Grasp the frame by the lower edge, and lift the lower edge up until the top edge pops out from beneath the upper clip.

apple computer

REMOVING AND REPLACING THE MOUSE

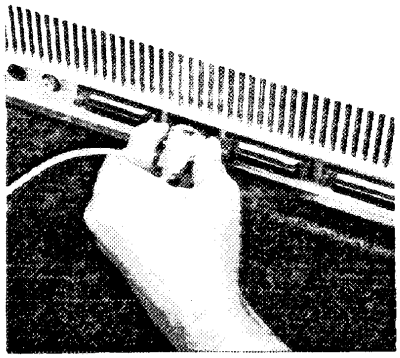
The mouse cord should be attached to its socket on the back of the Lisa. If it is not attached, simply center the connector on the socket and push it in.

Removing it is more difficult, because if it is done incorrectly, you may cause the mouse socket to break off. Remove it as follows:

1. With one finger on either side of the mouse plug, squeeze in on the soft plastic surrounding the connector.

   IMPORTANT: You **must** squeeze the sides of the connector while unplugging it, or you may damage the socket.

2. Pull the cord free from the socket.



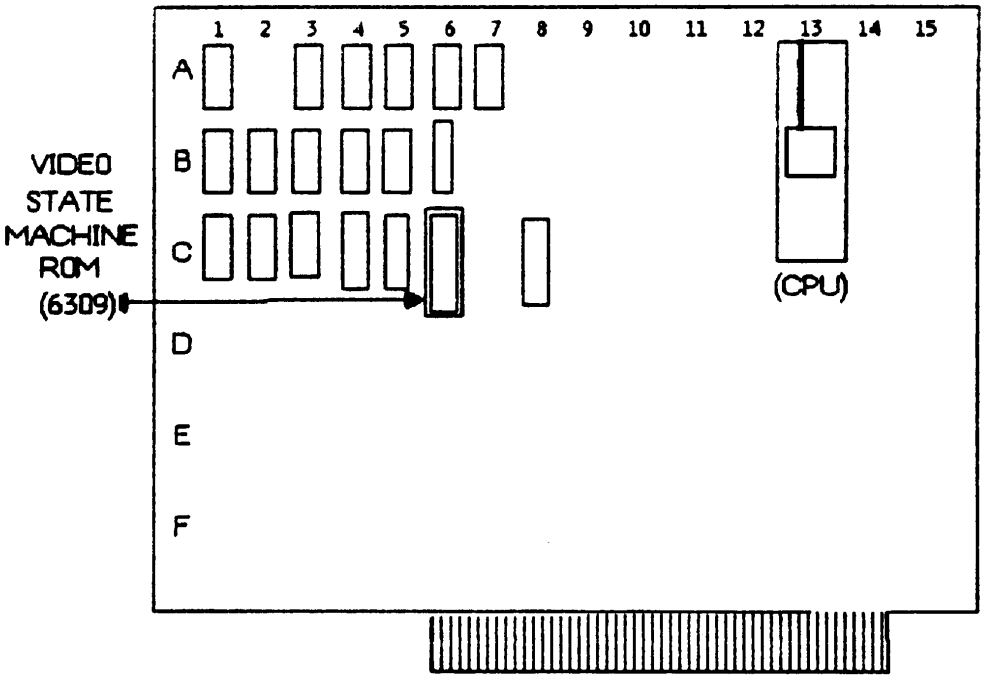
CONNECTING AND DISCONNECTING THE KEYBOARD

The keyboard plugs into the Lisa just under the ON-OFF button on the front of the chassis (under the disk drives). To disconnect it, simply pull on the rubber connector, as close as possible to the head of the connector. To connect it, just push the connector into its socket.

apple computer

INSTALLING A NEW CPU BOARD: TRANSFERRING THE VIDEO STATE MACHINE ROM

The Video State Machine ROM (6309 chip) is found at position C6 on the CPU board (see Figure 1, below). This ROM contains the serial number of the Lisa, which is used as its address for any network applications. This chip is also used in the software protection system. Whenever you change the CPU board on a Lisa, you must transfer this chip from the old board to the new board; otherwise the user's software will not run on the Lisa.



apple computer

LISA PACKING INSTRUCTIONS

There are only two, but they are important.

1. Use the box it came in.

2. **THE CRT MUST FACE DOWN!!**

apple computer

Lisa Technical Procedures

Section 2

Set-up

Contents:

apple computer

apple computer

INTRODUCTION

This job aid includes all the steps in a Lisa installation. Appendix 2, a checklist, is a summary of the procedure.

If you have had Lisa Level 1 training, you will have all the background you need for these procedures. If you have not had that course, be sure to go through LisaGuide and the Service section of the Lisa Owner's Guide before you attempt these procedures.

Before you leave the users' site, be sure to give them the Lisa Customer Orientation card and get them started on the Lisa.

MATERIAL REQUIREMENTS:

Item	Part Number
Lisa, with Lisa Accessories Kit	A6P0001 (A6M0101)
ProFile, with Lisa ProFile Accessories Kit	(A9M0005) (A6C0005)
Apple Dot Matrix Printer with Lisa DMP Accessories Kit	A2M0058 (A6C0350)
or	
Apple Daisy Wheel Printer with Lisa DWP Accessories Kit	A3M0025 (A6C0351)

IMPORTANT: The Lisa accessories kit that comes with each peripheral contains the cables necessary to connect the peripheral to a Lisa. In most cases, the peripherals will not work correctly if you try to use cables meant for an Apple II or other computer. If you don't have the proper Lisa accessories kits, get them!

apple computer

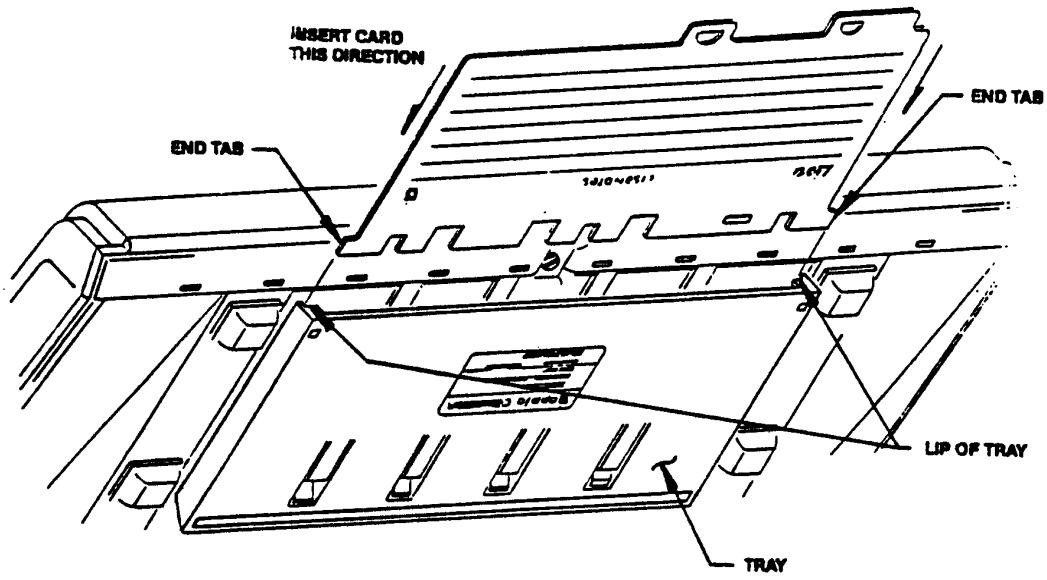


FIGURE 1

INSTALLING PULL-OUT REFERENCE CARDS

apple computer

A. UNBOXING THE LISA

The Lisa comes in two boxes. One holds the Lisa itself; the other holds the accessories kit, including the keyboard, the mouse and the power cord.

1. Slide the Lisa out of its carton. Remove the foam padding.

2. Set the cabinet on a hard, flat surface. (Watch your back - it's heavy.) Leave at least 2 inches of clearance on each side, to allow for proper ventilation.

3. Unbox the keyboard, the mouse and the power cord.

B. INSTALLING THE PULL-OUT REFERENCE CARDS

A set of pull-out reference cards is packed in the accessories box of every new Lisa. These cards fit into the tray under the Lisa keyboard.

IMPORTANT: BEFORE INSTALLING THE CARDS, FILL OUT THE "SUPPORT INFORMATION" SECTION OF CARD 4, "CONFIGURATION/ SUPPORT". CUSTOMERS NEED THIS INFORMATION FOR ANY WARRANTY REPAIRS AND PHONE SUPPORT THEY MAY REQUEST.

1. Prop up the keyboard so that the bottom is facing you.

2. Start with the Configuration/Support card, labelled 4 on the front and 1 on the back.

   a) Hold the card upside down as shown in Figure 1, with the blank side facing you and the end tabs next to the keyboard.

   b) Align the two end tabs with the lips at the ends of the tray.

   c) Using both hands, simultaneously push both end tabs behind the lips of the tray so that the card slides into the tray.

3. Repeat with the Windows/Text card (labelled 3 on the front and 2 on the back), installing it behind the Configuration/Support card.

4. Repeat with the Icons card (labelled 2 on the front and 3 on the back), and then with the Keyboard card (labelled 1 on the front and 4 on the back).

apple computer

To remove the pull-out reference cards (in case of error):

a) Prop up the keyboard so that the bottom is facing you (see Figure 1).

b) Starting with the card closest to the keyboard, pull the card out as far as it will go.

c) Hold the card firmly on either the right or left side, as close to the keyboard as possible.

d) Insert a straightened paper clip (or any other pointed tool) into the square hole in the tray at whichever side you are holding.

e) Push in the paper clip while pulling the card out of the tray. When the end tab of the card clears the lip of the tray, the card can be removed from the tray.

f) Repeat steps b through e for each card, always removing the card closest to the keyboard.

C. CHECKING THE BATTERY SWITCH

1. Remove the back panel and find the set of four batteries on the lower right side of the I/O board.

2. Find the switch next to the batteries, and make sure the switch is set to ON (toward the left).

If you are installing a Dot Matrix Printer, leave the back cover off until you have installed the Parallel Interface Card (see next page).

apple computer

D. INSTALLING LISA ACCESSORIES

1. If you have a Dot Matrix Printer to install, you must first install a Parallel Interface Card (PIC) in a Lisa expansion slot, following the steps below.

   a) Install the PIC in expansion slot 2 at the right rear of the Lisa. Be sure to remove the slot cover and store it on the back panel.

   b) Replace the back panel.

2. Attach the mouse cord to the mouse socket on the back panel of the Lisa.

3. Attach the keyboard cord to the front panel of the Lisa, under the square white Soft Switch (below the disk drives).

4. With the back panel replaced, connect the power cord to the Lisa; then plug it into the wall.

apple computer

E. INSTALLING THE PROFILE

1. Unbox the ProFile and its cables. (The power cord and interface cable are in a small box within the main ProFile box.)

2. Connect the ribbon cable to the ProFile and to the built-in parallel port at the back of the Lisa.

3. With the ProFile power switch OFF, connect the power cord to ProFile and to wall current.

4. Turn on the ProFile and wait for the red ready light to become steady (about a minute).

apple computer

F. INSTALLING THE OFFICE SYSTEM SOFTWARE

The Lisa Office System can be loaded on to the ProFile from two diskettes, called Office System 1 and 2, which are packaged with the Lisa Owner's Guide. Once the Office System is on the ProFile, you can copy the six basic Lisa tools (LisaDraw, LisaCalc, etc.) onto the ProFile from tool master diskettes. (The tool master diskettes are packaged with the tool manuals.) Thereafter, the tool master diskettes are only needed as a backup to the ProFile, in case the software needs to be reinstalled after a system crash.

Follow these procedures ONLY if your ProFile is blank or if you want to replace or reinstall all the software. (If you are replacing only one or two tools, use the method given in Appendix 1.)

NOTES:

a. If you are installing a new Lisa system, make sure that you are using new (i.e. never before copied) **tool master diskettes**, and that the diskettes you are copying are meant to be used on this particular Lisa. Tool master diskettes that have been copied by one Lisa can never thereafter be copied onto another Lisa, and copies made from them (whether on ProFile or on diskette) can never be used on another Lisa.

If you have more than one Lisa, you need a separate set of tool master diskettes for each. (This does not apply to the Office System 1 and 2 diskettes, nor to LisaTest, Lisaguide or data diskettes.)

b. Do not attempt to install LisaTest, LisaGuide or data diskettes onto the ProFile using this method. LisaTest and LisaGuide must be run from diskette and cannot be copied onto ProFile by this method.

c. Be careful to avoid accidentally trying to install a tool twice; attempting to do so will wipe out most of the software already installed, and you will have to repeat the entire process.

d. Start with the Lisa power off. If the Lisa is already on, turn it off by pressing the ON-OFF button.

apple computer

1. Turn on the Lisa by pressing the ON-OFF button once. After a few seconds, you should hear a click, as the Lisa begins its self-test sequence. When you hear the click (or after about 15 seconds), hit any key (except CAPS LOCK).

   After a few moments, the screen will prompt you to specify the startup device. (If you do not hit a key before the Lisa double-clicks, the Lisa will try to start up from the ProFile or one of the disk drives. If that happens, wait until the process is finished; then press the ON-OFF button to turn the Lisa off. Then repeat this step.)

2. Insert the diskette labelled "Office System 1" into drive 1 (the upper built-in drive). (Hold the diskette so that the cutout parts enter the drive first.)

3. Insert "Office System 2" into drive 2 (the lower built-in drive).

4. Use the mouse to select the icon of drive 1.

5. A screen like Figure 2 will appear (but with only three options). Roll the mouse on your desk until the pointer is over the box that says "Install".

6. Click the mouse button once. Now the Lisa will install the system software on the ProFile. (This will take several minutes.)

7. When the installation is finished, the lower disk drive will eject its diskette and the screen will say "The startup software has been installed." Take out the ejected diskette, put it in its envelope, and click "OK".

apple computer

8. The next screen will ask if you have another diskette to add to the ProFile. Insert a new (i.e., never before copied or installed) tool master diskette into drive 2 (see NOTES at top of this section). When you insert a new diskette you will see this message:

> The Lisa is about to make the first copy of the [tool name]. This copy and all future copies can be run only on this Lisa. Is that what you want?

If you want to proceed, click "Copy". (If not, click "Cancel".)

Lisa will automatically install the contents of the diskette on the ProFile, eject the diskette, and ask if you have another. Continue until all tool master diskettes have been installed. Then click "Done".

9. Now the Lisa will display the screen shown in Figure 2. This time, click "Finished".

10. Next the Lisa will ask if you want it to turn off or to start up from the ProFile. Select "Start up".

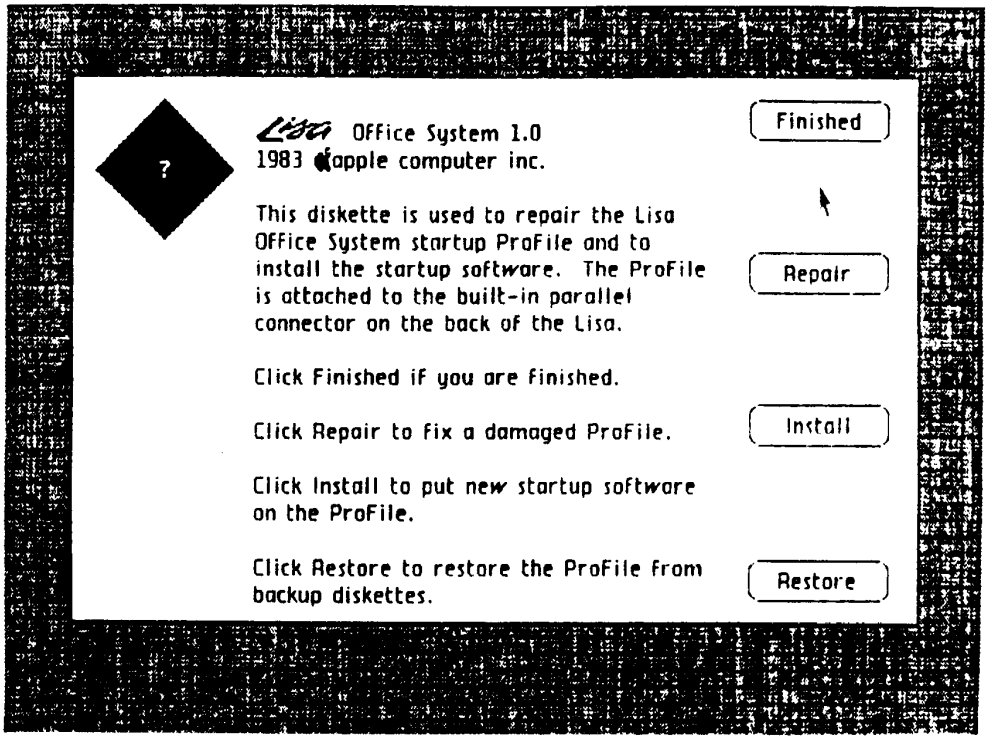


FIGURE 2

apple computer

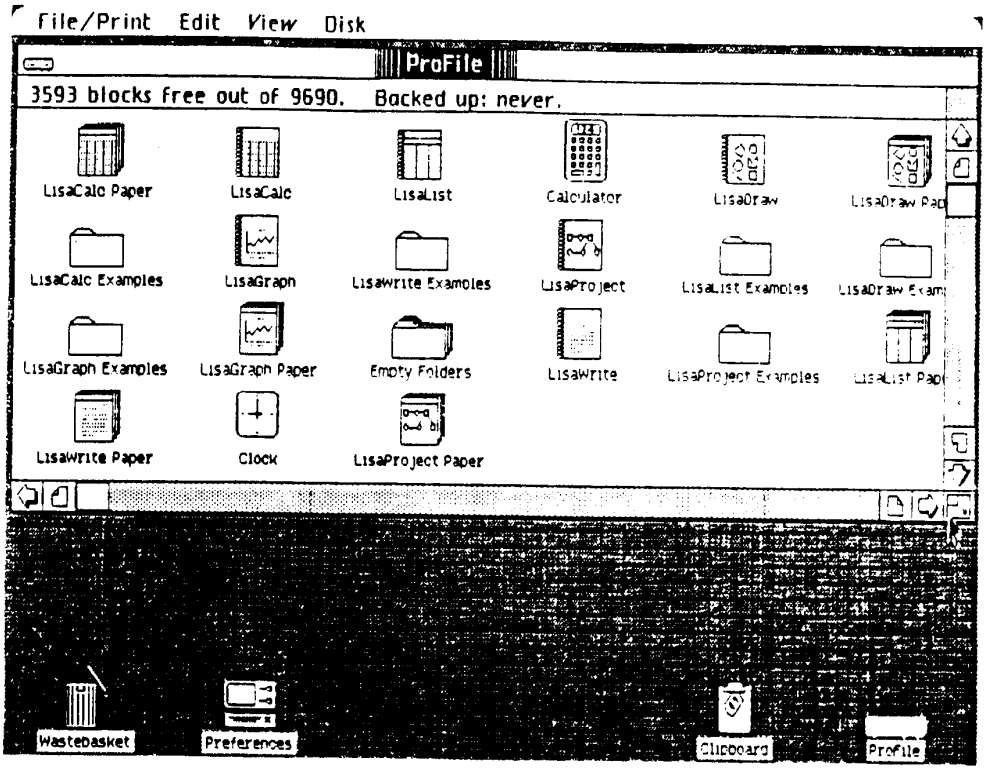


FIGURE 3

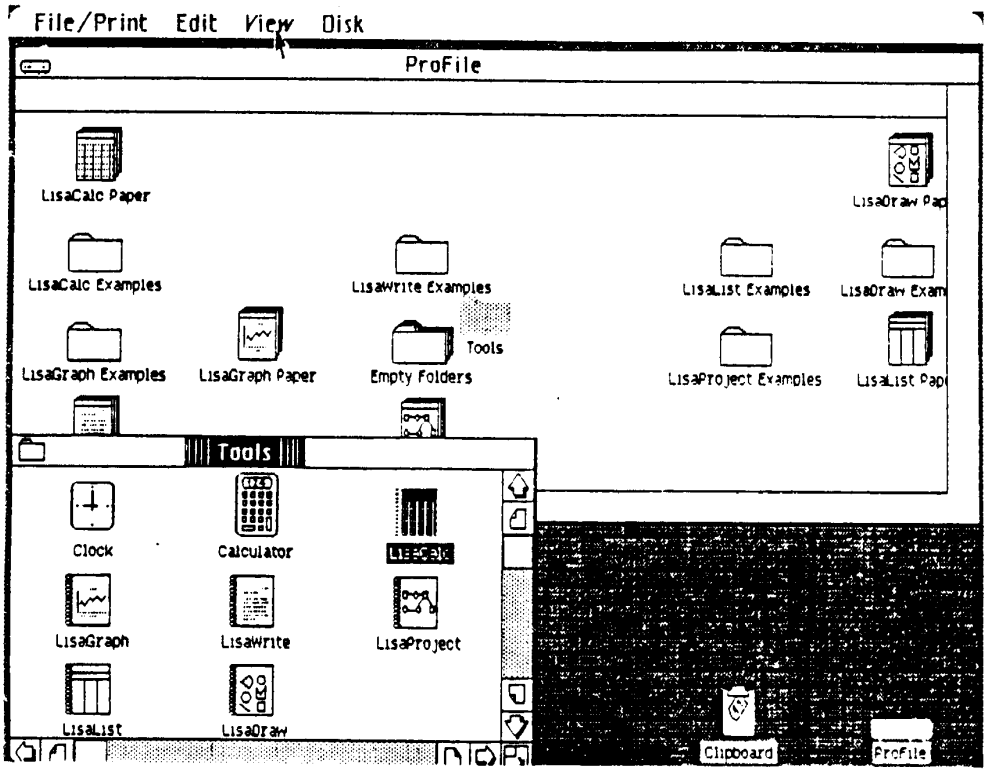


FIGURE 4

apple computer

G. PUTTING THE ICONS IN ORDER

Each tool diskette puts three icons onto the ProFile: a **pad of paper** (e.g. "LisaCalc Paper"), a **file folder** of examples (e.g. "LisaCalc Examples"), and a **spiral notebook** (e.g. "LisaCalc"). (Find these items in Figure 4 to see what the different icons look like.) When you first open the ProFile window after installing the software, these icons will be stacked one on top of another, so that many will not be visible. They need to be unstacked and repositioned to match the diagrams in the user training materials. To do that, follow the steps below.

1. Open the ProFile icon (double-click). Use the mouse to enlarge the ProFile window to the approximate shape and size shown in Figure 3.

2. Pull down the View menu and select "Straighten Up Icons". (This will unstack any stacked icons and straighten the rows and columns of the display.)

3. If necessary, use the mouse to enlarge the ProFile window so that you can see all the icons (see Figure 3).

4. Find the "Empty Folders" icon and double-click on it. The Lisa will create a new folder with the label "Untitled".

5. Make sure that "Untitled" is selected (black); if not, click once on the icon. Then type Tools, and that word will replace "Untitled" on the title line.

6. Open the new Tools folder (double-click), and use the mouse to give the Tool and ProFile windows the size and shape shown in Figure 4. Position them so that they overlap as little as possible.

7. The **tool icons** are the spiral pads labelled "LisaWrite," "LisaDraw," etc. You can identify them by the spiral along the left side of the icon. Use the mouse to move the tool icons, and the Clock and Calculator, from the ProFile window onto the Tool window, in the positions shown in Figure 4.

8. Make sure the Tools window is active (title should be white-on-black as in Figure 4; if not, click once anywhere on Tools window). Pull down the View menu and select "Straighten Up Icons". (If the icons rearrange themselves into more or fewer columns than you had planned, the window is too wide or too narrow: use the mouse to change its size. Then repeat steps 7 and 8.)

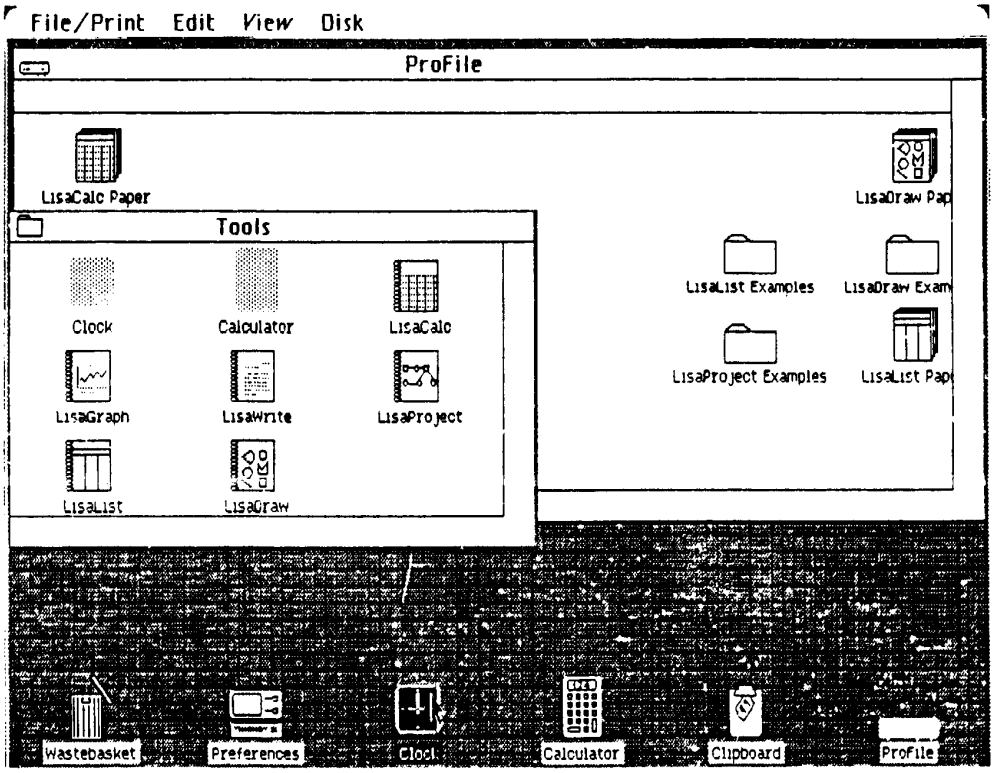


FIGURE 5

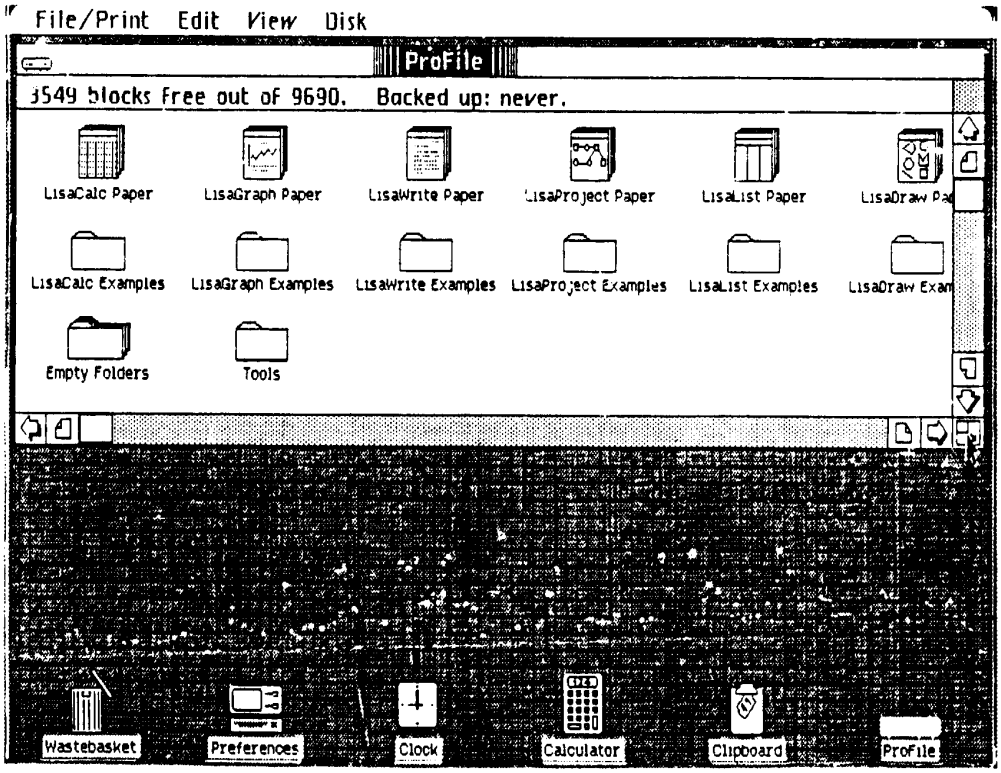


FIGURE 6

apple computer

9. Move the Tools window into the position shown in Figure 5.

10. Use the mouse to move the Clock and Calculator from the Tools window onto the desktop. Position them as in Figure 5.

11. Put away "Tools" on ProFile (double-click on small icon at upper left corner of Tools window).

12. Move the remaining icons into the positions shown in Figure 6.

13. Make the ProFile window the size and shape shown in Figure 6.

14. Make sure the ProFile window is active (title should be white-on-black; if not, click once anywhere on the window.) Then open the View menu and select "Straighten up Icons". Now the Lisa will straighten up the icons in the ProFile window.

15. Set aside ProFile (double-click on small icon at upper left corner of ProFile window).

16. Make sure the icons on the desktop are in the order shown in Figure 6. Open the View menu and select "Straighten up Icons".

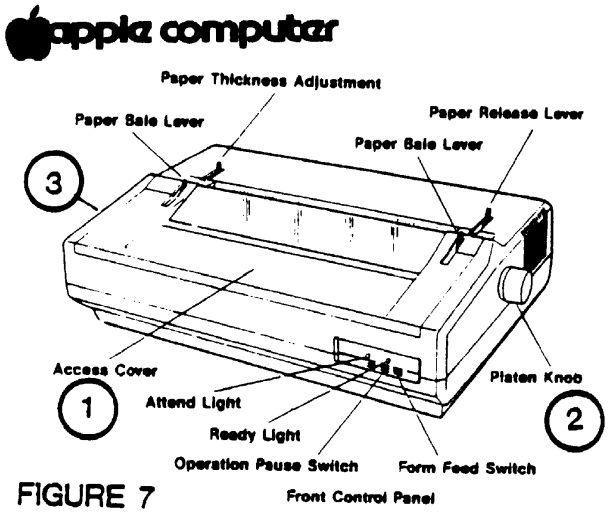


FIGURE 7

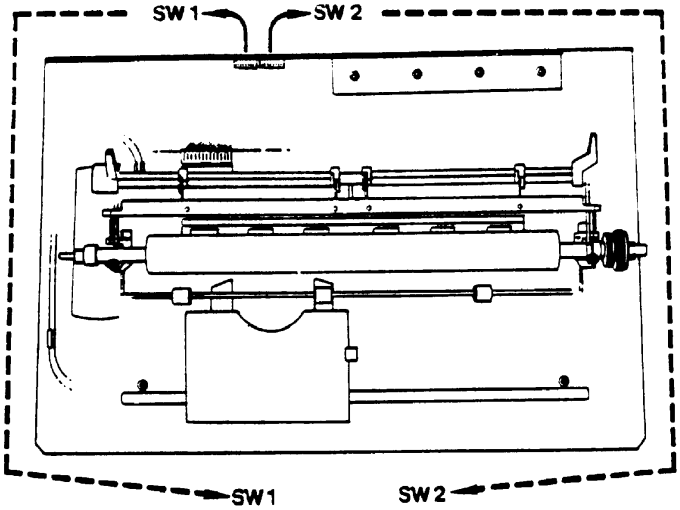


FIGURE 8

apple computer

H. CONFIGURING AND INSTALLING AN APPLE DAISY WHEEL PRINTER

Before you attach a DWP to a Lisa, you must set the configuration switches inside the DWP to be compatible with the Lisa. If you are not installing a DWP, skip this section.

1. Open the printer as follows:

   a) With power off, remove the access panel (Figure 7, #1) by pulling it forward.

   b Remove the two screws inside the front panel of the printer (one on each side).

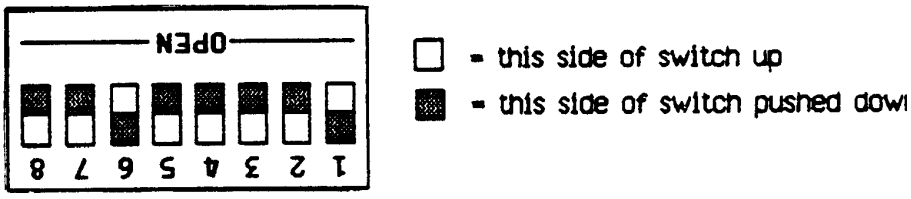
   c Remove the two screws at the rear of the printer.

   d) Pull off the platen knob (Figure 7, #2).

   e) Lift off the cover (Figure 7, #3).

2. Locate the two sets of configuration switches at the back of the DWP (see Figure 8). Set them as pictured in Figure 8.

3. Locate the user-accessible DIP switch just inside the front of the printer. Make sure it is set as follows.



4. Return cover, screws, platen knob and access cover. Insert paper.

5. Connect the DWP to either serial port at the back of the Lisa, using an RS 232 cable and a modem eliminator cable.

6. Make sure DWP power switch is set to OFF. Then connect power cord to DWP and to wall current.

7. Install paper. **IMPORTANT:** Do not turn on the DWP yet. When you turn the Lisa on, its internal I/O test sends signals to the serial ports. If the printer is on at that time, it will print garbage and seem to have gone crazy. This does not indicate a printer problem.

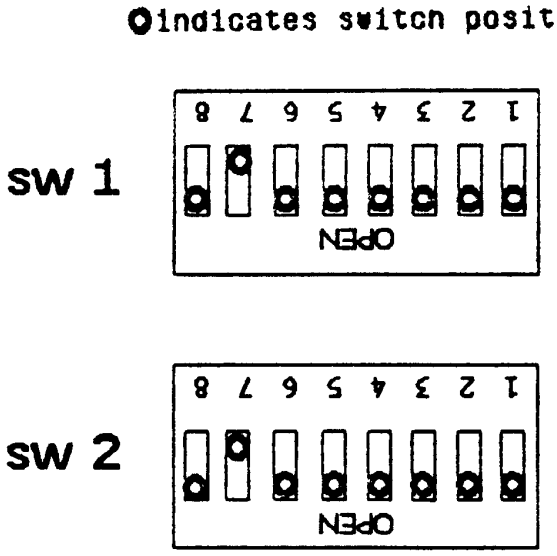
apple computer

I. INSTALLING AN APPLE DOT MATRIX PRINTER

If you are not installing a DMP, skip this section.

1. With power OFF, remove the front access panel from the DMP by lifting up on the front edge.

2. Inside the printer, under a plastic strip at the right, are two green DIP switches. On each switch, switch #7 should be closed and all the rest open. The switches should look like this:



3. Connect DMP cable connector to back of DMP and to upper connector of Parallel Interface Card in Lisa.

4. Make sure DMP power switch is set to OFF. Then connect power cord to DMP and wall current.

5. Install paper and turn printer on.

apple computer

J. SETTING PREFERENCES

"Preferences" gives you control over Lisa's input-output devices. Whenever you connect or disconnect a device from the Lisa, you must inform the Lisa of that fact by means of the "Device Connections" menu in Preferences.

1. Open Preferences icon (by double-clicking with the mouse). Note the three choices at the top of the Preferences window: "Convenience Settings," "Startup," and "Device Connections".

2. Move pointer to "Device Connections". When the pointer becomes a check mark, click once on the mouse button.

3. On the next screen, choose "Parallel" (click once).

4. When asked what device you intend to connect, click on "ProFile".

5. When Note screen appears, click "OK".

6. If you have installed a Dot Matrix Printer, choose "Expansion 2 upper" (click once).

7. When asked what device you intend to connect, click on "Dot Matrix Printer".

8. When Note screen appears, click "OK".

9. When "Setup of Apple Dot Matrix Printer" appears, select appropriate settings.

10. If you have installed a Daisy Wheel Printer, choose the box for the Serial Port (A or B) to which you connected it. When asked what device you intend to connect, check "Apple Daisy Wheel Printer".

11. When Note screen appears, click "OK".

12. When "Setup of Apple Daisy Wheel Printer" appears, select appropriate settings.

13. Choose "Startup" from top of Preferences window.

14. On the Startup screen, choose "Start Up From Disk Attached to Parallel Connector" (i.e., the ProFile). Then choose "Brief Memory Test".

15. Set aside Preferences by double-clicking at the upper left-hand corner of the window.

CONTINUED ON NEXT PAGE

apple computer

16. To cause the Lisa to use the Preferences you have just selected, use the following procedure:

    a) Press the ON-OFF button. Wait for the light in the ON-OFF button to go out.

    b) Press the ON-OFF button again. Now Lisa will come on again, with your Preferences operating.

K. SETTING THE CLOCK

1. Open the clock icon (select with mouse and double-click).

2. Move the mouse over desired time or date item and click once. When item is highlighted, type correct value. Continue until all items on clock are up to date.

3. Set aside the clock (double-click in upper left corner).

L. TESTING THE SYSTEM: PRINTING A DOCUMENT

1. Make sure printer(s) are on.

2. Open ProFile icon with mouse (double-click).

3. Open examples folder for any application (LisaDraw is good for graphics demonstration).

4. Double-click on one of the examples, to create a new document ("Untitled"). Then double-click on "Untitled," to open it.

5. Pull down the File/Print menu and select "Format for Printer". Make the appropriate settings for the system at hand. Then click in the "OK" box.

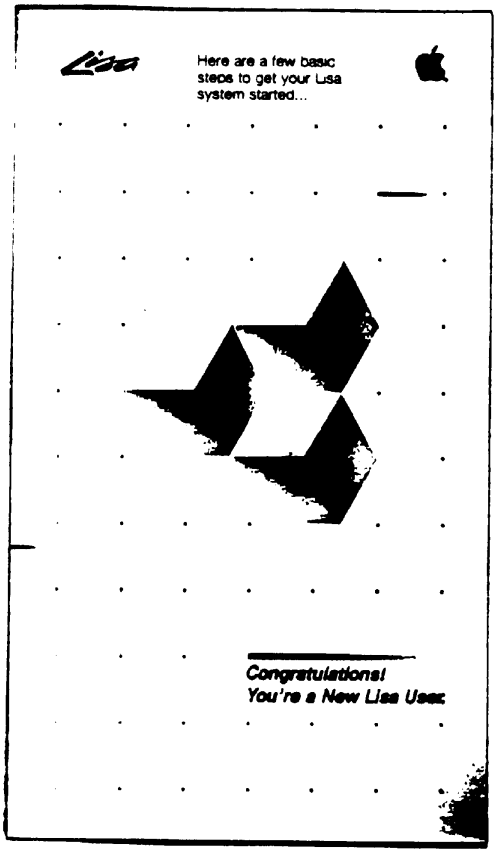
6. Pull down the File/Print menu and select "Print". Make the appropriate settings. Then click in the "OK" box.

If the document prints, the Lisa is functional. If not, check the printer cables. If they are properly seated and the document still will not print, check the Troubleshooting section of Lisa Owner's Guide or Level 1 Technical Procedures.

apple computer

M. GETTING THE USER STARTED

After setting a system up for a customer, give the new owners the Lisa Customer Orientation Card (see illustration below) and go over it with them, to help them get started with their Lisa. You should make sure that they can turn the system on and off properly and that they can start up LisaGuide before you leave.



apple computer

APPENDIX 1

Replacing a Single Tool on the ProFile

If you accidentally discard a tool icon or pad-of-paper icon and want to replace it, you should use the method described here rather than the method given in section D (using the Office System 1 and 2 diskettes).

1. Turn the Lisa on and start up from the ProFile.
2. Insert the tool master diskette in either drive.
3. When the diskette icon appears on the screen, open it (double-click with mouse). Select and **duplicate** the desired icon (use the File/Print menu).
4. Move the highlighted duplicate icon into the ProFile. (If it is a tool icon (spiral notebook), open the ProFile icon and the Tools folder, and move the tool icon into the Tools folder.)

apple computer

APPENDIX 2

Set-up Checklist

1- Serial number and support information written on pull-out cards?

2- Pull-out cards installed?

3- I/O board batteries on?

4- Parallel Interface Card installed in expansion slot 2 (for DMP)?

5- Software loaded onto ProFile from this Lisa's tool master diskettes?

6- Icons put in correct order?

7- Daisy Wheel Printer:

   a) All three internal switches set correctly?

   b) Correct cable and modem eliminator cable?

8- Dot Matrix Printer

   a) Both internal switches set correctly?

   b) Correct cable?

   c) Connected to upper connector of Parallel Interface Card?

9- Preferences set correctly?

10- Clock set?

11- Document prints properly?

12- Customer knows how to begin working with Lisa?

Lisa Technical Procedures

Section 3

Video Take-apart

Contents

SAFETY PRECAUTIONS

The Lisa, with its built-in video monitor, is harmless as long as you're just watching the display. Removing the cover, however, exposes you to the high-voltage Cathode-Ray Tube (CRT)--the picture tube. The following precautions must be taken to ensure your safety, especially when you are making adjustments on a live monitor.

Safe Electrical Setup

1. **Be sure your outlet is correctly wired and properly grounded.**

   Polarity and ground testers are available from most electronics stores. Test all outlets in your service area before working on **any** electrical equipment. If you have any doubts about your building's wiring, consult a qualified electrician.

2. **Never use an adaptor plug to connect a monitor's three-prong power plug to a two-prong wall outlet.**

   Adaptors defeat the ground pin, which is a safety feature.

3. **Use an isolation transformer between the monitor and the outlet when performing live adjustments.**

   Order an isolation transformer from your electronics distributor, and make it a practice to use it whenever you are working with **any** monitor or other powered system under test. An isolation transformer isolates the circuitry of the system under test from the power company's circuitry, reducing the likelihood of a fatal shock should you simultaneously contact high voltage and anything else that is earth-grounded.

   Do not connect more equipment to the transformer than the wattage capacity of the transformer will bear. (It is usually best to connect only one piece of equipment at a time.) We recommend an isolation transformer with a minimum wattage capacity of 500 VA, with a grounded three-prong cord and receptacle. Two such transformers, available from many electronics stores and distributors, are listed below:

   Triad N-57MG Stancor GIS 500

CRT Safety Rules

1. **Do not work on a monitor alone.**

   In case of accident, it could save your life to have someone else nearby. Apple recommends that your staff be trained in Cardio-Pulmonary Resuscitation (CPR).

2. **Remove rings, watches, bracelets, hanging necklaces, and other jewelry before performing repairs on a monitor.**

   Metal jewelry is an excellent conductor of electricity. Removing jewelry will reduce the possibility of electric shock.

3. **Never use a grounding wriststrap or heelstrap or work on a grounded workbench mat when discharging a monitor or when performing live adjustments.**

   Grounding wriststraps, heelstraps, and mats are used to protect sensitive components from the damaging effects of electrostatic discharge from your own body or clothing. Even though they contain a one-megohm resistor and are designed to conduct only small electrical charges, we recommend that they be used **only** when working on "dead" (uncharged) equipment.

4. **Wear safety goggles when working with a CRT.**

   The CRT contains a high vacuum. If cracked or broken, it can implode (collapse into itself, then explode). To protect your eyes from serious injury, always wear safety goggles when working on or near a CRT, and be careful of other people in the area.

5. **Before working inside a monitor, turn off the power and disconnect the AC power cord.**

   Certain parts of a monitor chassis are hot (electrified) when the monitor is under power. Except when you must have the power on (for example, when making live adjustments), never work on a plugged-in monitor--even if you have the power turned off.

6. **Keep one hand in your pocket or behind your back when working on a live monitor.**

   This practice reduces the risk of current passing through your heart, should you accidentally contact high voltage.

7. **Always discharge the anode before touching anything inside the monitor.**

   The anode of the CRT maintains a charge of about 15,000 volts DC (even when the power is off). Before touching any internal components you must discharge this voltage. The anode can regain some charge, even after it has been discharged. If the service procedure takes more than 30 minutes, the anode should be discharged again.

8. **Never touch the anode connector or the anode aperture.**

   Normally the anode aperture has a connector plugged into it (Figure 1, #2). When a CRT is replaced, the anode connector is removed, exposing the anode. The anode can maintain a charge of several thousand volts (even after the power is off).

9. **Do not pick up or handle a CRT by its neck.**

   To prevent an implosion, take every precaution against breaking the tube. Be especially careful with the neck, the area where the tube is the thinnest.

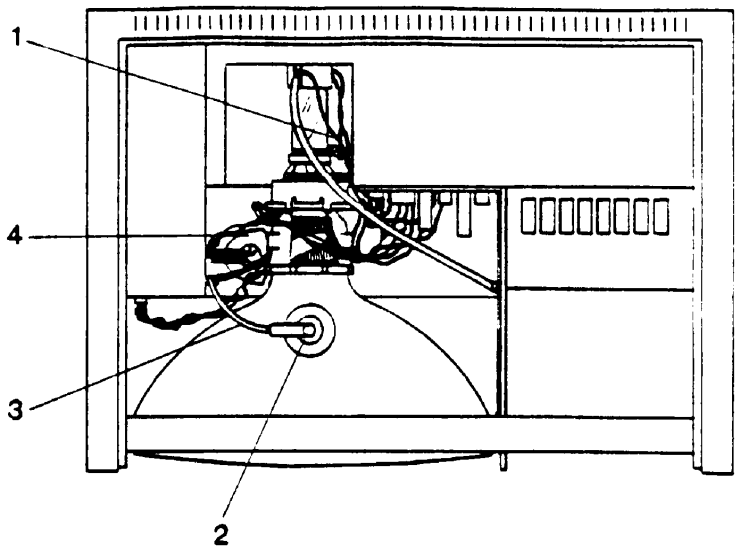


FIGURE 1

Live Adjustment Rules

In addition to the precautions listed on the previous pages, never touch the following components when adjusting a live CRT:

1. The yoke wires (Figure 1, #1)
2. The anode connector (Figure 1, #2)
3. The anode wire (Figure 1, #3)
4. The flyback transformer (Figure 1, #4)

apple computer

DISCHARGING THE CRT

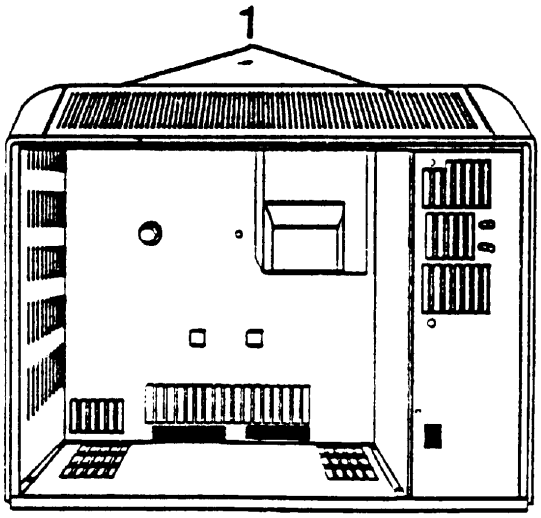
WARNING! WHEN WORKING ON A LISA THE FOLLOWING STEPS CAN BE DANGEROUS IF NOT EXECUTED PROPERLY.

A (1.) If the Lisa is on, press the ON-OFF switch. When it is finished powering down, unplug the Lisa.

(2.) Remove the front panel, back panel, and card cage.

(3.) Remove the top of the Lisa. It is joined to the chassis by screws, which are permanently attached to the chassis. These two screws are found 'hidden' on the underside of the roof of the card cage chamber toward the back of the machine. To access them you have to poke your Phillips screwdriver up through the round holes in the flap that is part of the roof of the card cage chamber. See Figure 2, #1.

FIGURE 2



(4.) Lift off the top panel from the back of the Lisa.

(5.) **Put on the safety goggles.**

(6.) **Remove any rings, wrist watches, and bracelets.**

apple computer

FIGURE 3

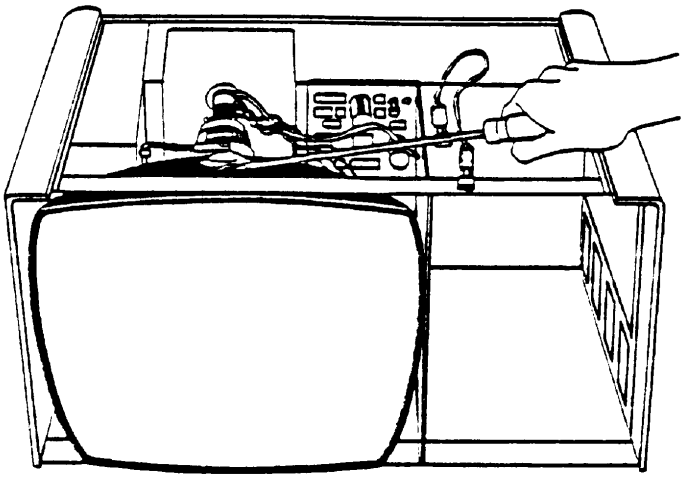
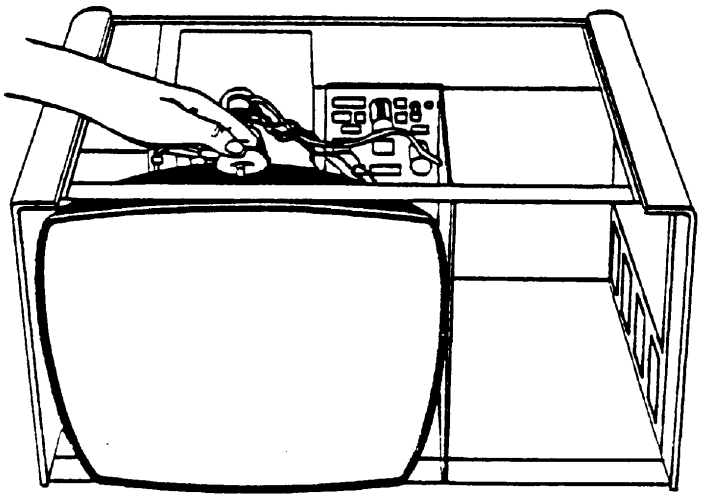


FIGURE 4



B 7. Attach one alligator clip to the screwdriver two inches from the handle, and the other to the metal chassis.

8. Put one hand in your pocket or behind your back. With your other hand grasping ONLY the insulated handle of the screwdriver, insert the screwdriver under the CRT anode cap. See Figure 3. Be sure the blade comes into contact with the anode ring.

CAUTION: DO NOT USE FORCE. If it is difficult to get the screwdriver under the anode cap, put down the large screwdriver and use a smaller screwdriver to loosen the suction of the anode cap on the tube. Remember, keep one hand behind your back while loosening the suction. Once the suction is relieved, proceed to discharge the anode with the large screwdriver as described above.

9. Remove the screwdriver.

10. Remove the alligator clips.

11. With one hand behind your back remove the anode cap. (Pull back on the rubber of the anode cap. First push one way, then the other, to loosen and remove it.) See Figure 4.

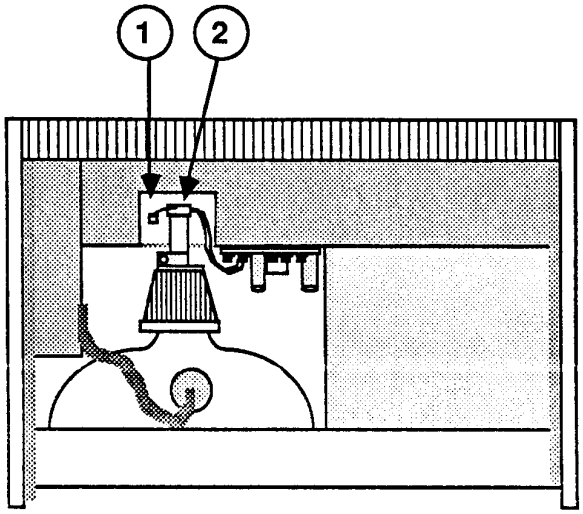


FIGURE 5A

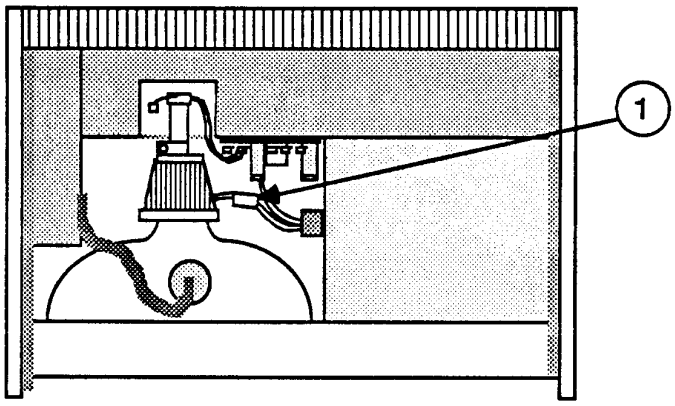


FIGURE 5B

REMOVING THE CRT

1. Put on safety goggles, remove the cover, and **discharge the CRT.**

   WARNING: When working in the video chamber, avoid touching the anode and the anode cap--even after the CRT has been discharged. The anode can regain some charge over time.

1A. Place the Lisa/Macintosh XL on a grounded workbench mat and put on your grounding wriststrap.

The CRT cup (Figure 5A, #1) is the part of the chassis that surrounds the CRT neck. In the following steps, you will remove the cables, screws, and ground wire that are attached to the CRT cup. The ground wire (the single white wire that runs from the yoke to the contact on the chassis) is difficult to remove safely. You will do that last so that you can orient the CRT cup away from the CRT neck.

C (2.) Remove the wires from the clamps on the side of the CRT cup.

(3.) Supporting the cup, remove the four screws that secure the cup to the chassis. Three screws are accessed through the video chamber and one through the card cage chamber.

(4.) Remove the round plug from the socket at the end of the CRT neck (Figure 5A, #2). (If the plastic guide comes off the tube with the plug, replace it.)

(5.) Move the CRT cup so you can grasp the ground terminal and remove it safely from the contact on the floor of the CRT cup.

(6.) Turn the Lisa so that the front is facing you.

(7.) **For unmodified Lisa 2/Macintosh XL (Figure 5A):**

Remove the two (upper) yoke connectors from the video board. Be careful of the 25-volt capacitor directly above the second plug.

For modified Lisa 2/Macintosh XL (Figure 5B):

Disconnect the connector (Figure 5B, #1) between the screen kit transformer and the CRT yoke. Then disconnect the blue and red connector located at the right side of the video board.

WARNING: In the following steps, avoid touching the red-painted anode area of the CRT (Figure 5C, #1).

WARNING: If some time has elapsed since you discharged the CRT, discharge it again before you remove it. (The anode can regain some charge over time.)

D 8. Use the magnetic nutdriver to remove the screws from the four front corners of the CRT, removing the top screws last. Use one hand to steady the CRT while removing the top two screws.

9. Carefully remove the CRT by pulling it toward you.

   WARNING: Do not hit the tube against the chassis frame. Do not break the seal of the yoke to the neck.

10. Set the CRT aside, face down on a flat soft surface.

WARNING: If you are going to dispose of the CRT, read and follow the instructions for safe devacuuming in "Disposing of the Cathode-Ray Tube (CRT)" at the end of this section.

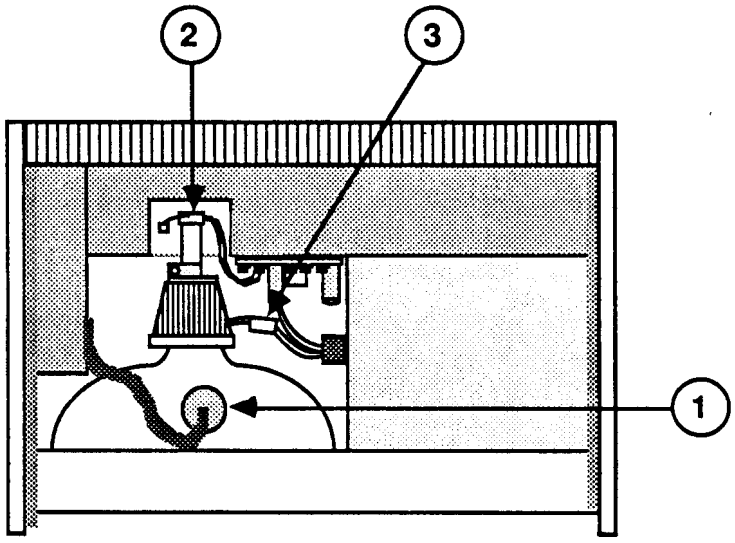


FIGURE 5C

INSTALLING THE CRT

I 1. Reclamp the flyback cable (red, high voltage wire) to the cable clamps on the wall of the video chamber.

2. Reconnect the ground wire (extending from the round yoke connector) to the contact on the floor of the CRT cup. Replace the CRT cup (Figure 5C, #2).

3. Reclamp the yoke socket cables to the cable clamps located on the wall of the CRT cup.

4. Carefully place the CRT where it is to be mounted (remember, the anode should be facing up).

5. While holding the CRT in place with one hand, attach the round yoke socket to the end of the CRT neck. Make sure that the pins are aligned correctly with the connector before pushing it on. The yoke connector only fits one way.

6. While supporting the CRT with one hand, install the bolts. Start all four bolts first; then tighten them down.

7. **For unmodified Lisa 2/Macintosh XL:**

   Connect the wires from the yoke to the connectors on the video board. When facing the front of the Lisa, the yellow and green wires go on the left side of the board and the red and blue wires go on the right side of the board.

   For modified Lisa 2/Macintosh XL:

   Connect the yellow and green yoke connector to the connector coming from the screen kit transformer. (See Figure 5C, #3.) Then connect the blue and red yoke connector to the socket at the right side of the video board.

   CAUTION: Do not mix up these wires or you will damage the CRT.

8. Clip the anode cap into the CRT.

9. Replace the top.

10. Replace the card cage.

11. Replace the back panel.

12. Replace the front panel.

REMOVING THE VIDEO BOARD

1. Discharge the CRT.

2. Remove the two yoke plugs (upper connectors) from the video board. Be careful not to injure the 25V capacitor directly above the second plug. These connectors can be difficult to remove.

E 3. Remove the flyback transformer connector from the video board. Squeeze the release catches on the top and bottom of the connector and use a rocking motion to pull the connector free.

4. Remove the two Phillips screws that attach the video board to the CRT.

   NOTE: If the screws drop and remain on the bottom, the flyback may short when the computer is turned on.

5. Pull out the video board.

REPLACING THE VIDEO BOARD

NOTE: IGNORE STEP 1 IF THE CRT IS ALREADY INSTALLED.

H 1. Replace the CRT cup.

2. Slide the video board into its connector.

3. Screw in the two screws that hold the video board in place.

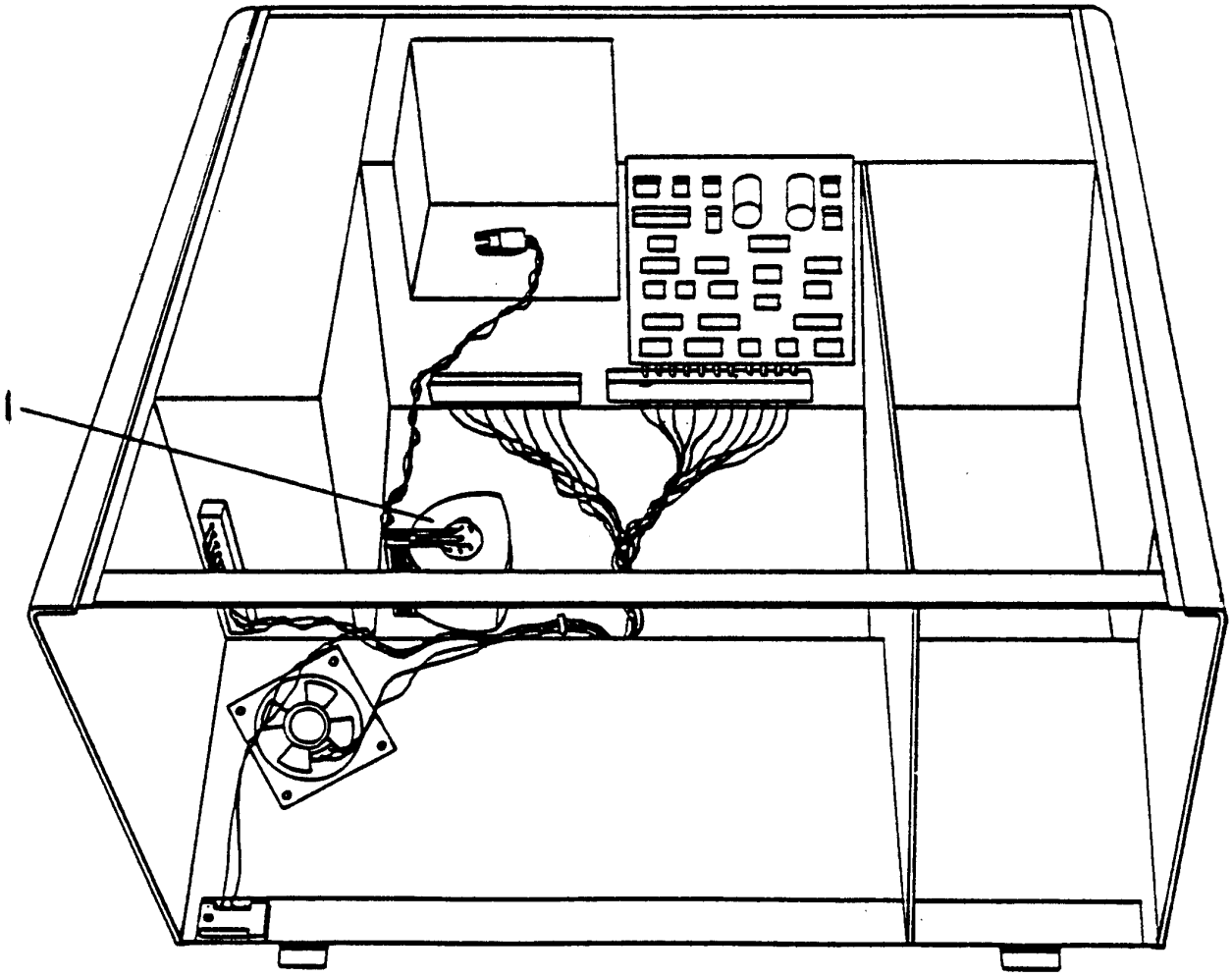
4. Connect the wires from the yoke to the connectors on the video board. When facing the front of the Lisa, the yellow and green wires go on the left side of the board and the red and blue wires go on the right side of the board.

5. Attach the flyback transformer connector.

6. Replace the top.

apple computer

FIGURE 6



apple computer

REMOVING THE FLYBACK TRANSFORMER

1. Discharge the CRT.
2. Remove the CRT.

F (3.) Remove the power supply

(4.) Remove the bottom pan by removing six phillips screws; four from the card cage chamber floor, and two from the power supply chamber floor.

(5.) Tilt the back of the Lisa forward and the bottom pan will fall free.

(6.) Turn the Lisa so that the front is facing you.

(7.) Pull the high voltage wire loose from the clamps on the side of the chassis.

(8.) Remove the flyback connector wires from the cable clamp near the floor of the video chamber.

(9.) Turn the chassis upside down with the front facing you.

(10.) While holding the flyback (See Figure 6, #1) from underneath with one hand, remove the two nuts that attach the flyback to the chassis from the bottom of the machine (which is now facing up) using a number 6 nutdriver.

11. Turn the chassis right side up.

REPLACING THE FLYBACK TRANSFORMER

G (1.) With the chassis lying upside down, orient the flyback so that the screws are sticking through the bottom of the chassis. Gently tighten the bolts.

Caution: These bolts are delicate. If you tighten the nuts too much the bolts may break off.

(2.) Replace the bottom plate. Slide the little feet of the bottom plate up into the bottom of the chassis. Carefully set the Lisa right side up. Replace the six screws, starting all of them first before tightening each one.

(3.) Replace the power supply.

4. Replace the CRT.

apple computer

REMOVING THE DISK DRIVE CABLE ASSEMBLY

1. Remove the disk drive cables from the two clamps on the bottom of the disk drive chamber. Apply downward pressure to the tab on the right side of the clamp (perhaps with the handle of a screwdriver) and simultaneously pull up on the body of the clamp.

2. Remove the cable from the board of the ON-OFF switch. (Push the tabs apart to release the cable.)

3. Remove the disk-drive-to-card-cage connector from the bottom back panel of the disk drive chamber. It is attached with two screw/starwasher/bolt assemblies. Access the bolt on the left side of this connector through the video chamber. The screws are accessible through the card cage chamber. Hold the bolt steady with a 1/4" crescent wrench or needlenose pliers from inside the video chamber and loosen the screw from inside the card cage chamber. The bolt on the right hand side of the connector is accessible through the disk drive chamber.

REPLACING THE DISK DRIVE CABLE ASSEMBLY

1. Replace the disk-drive-to-card-cage connector. Push the screw in from the card cage side, hold the nut and starwasher in place, and tighten the screw.

2. Plug ON-OFF switch cable into ON-OFF switch/keyboard assembly board.

3. Place the left disk drive cable on top of the right disk drive cable and insert both into the clamps on the bottom of the disk drive chamber. Lock the clamps.

apple computer

LOCATING THE POWER-SUPPLY-TO-CARD-CAGE-ASSEMBLY

The power-supply-to-card-cage-assembly winds through the video chamber from the power supply chassis frame to where it splits and supplies power to both the card cage and the video board.

1. The safety interlock switch, which is attached by one screw to the front, bottom, left of the video chamber, is located at Figure 7, #1.

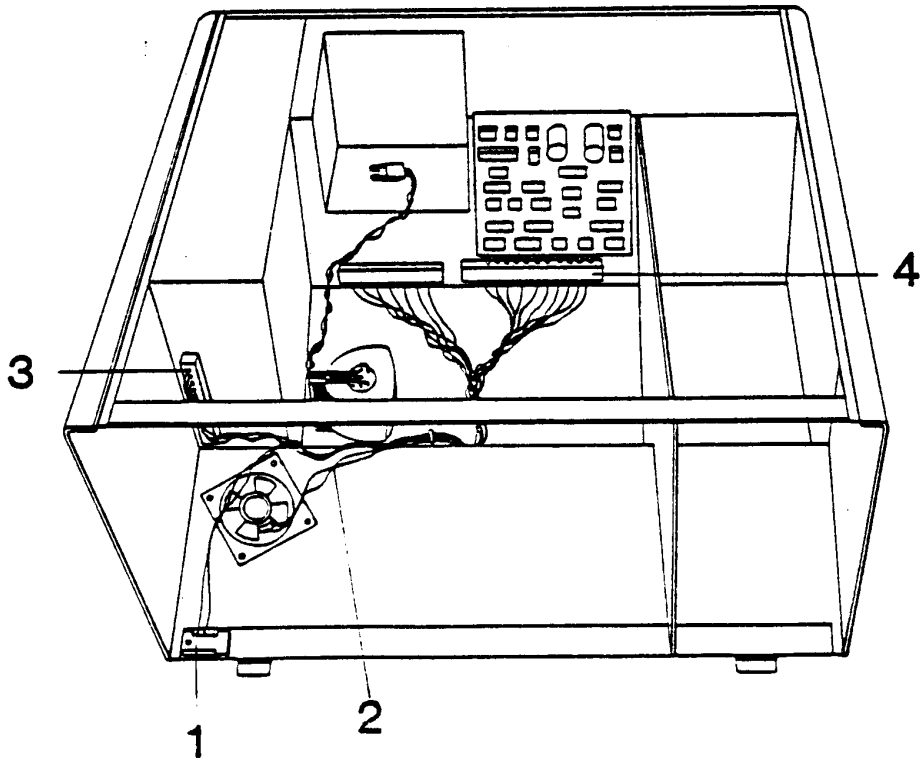
2. The speaker-to-assembly connector is located at Figure 7, #2.

3. The connector to the power supply chassis frame is located at Figure 7, #3. When you are replacing the connector be sure to replace the ground under the star washer when replacing the screw.

4. The video board connector is located at Figure 7, #4. When you are replacing the connector, be sure to replace the ground under the star washer when replacing the screw.

5. The assembly is attached to the card cage at Figure 7, #5.

FIGURE 7



REMOVING THE MACINTOSH XL SCREEN KIT TRANSFORMER

NOTE: The Macintosh XL Screen Kit is located in the video chamber of all Modified Lisa 2/Macintosh XL systems. If you are installing the screen kit for the first time, turn to **Upgrade and Retrofits, Section 4** for installation procedures.

1. Discharge the CRT. (See **Discharging the CRT.**)
2. Locate the screen kit transformer (Figure 8, #1). It is attached to the wall of the video chamber with adhesive tape.
3. Disconnect the connector (Figure 8, #2) located between the screen kit transformer and the CRT yoke.
4. Disconnect the green and white transformer connector from the left side of the video board.
5. Carefully peel the screen kit transformer (Figure 8, #1) off the wall of the video chamber.

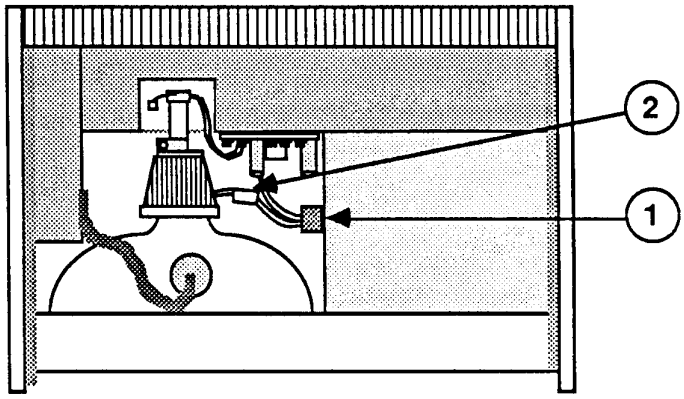


FIGURE 8

REPLACING THE MACINTOSH XL SCREEN KIT TRANSFORMER

1. Clean the section of the video chamber where the transformer was previously attached. This is the section adjacent to the disk drive chamber.

2. Connect the yoke connector (green and yellow wire) to the male connector attached to the transformer. (See Figure 9, #1.)

3. Connect the female transformer connector to connector P2 at the left side of the video board.

4. Peel the protective paper off the adhesive tape at the bottom of the replacement transformer.

5. Press the bottom of the transformer firmly to the side (cleaned section) of the video chamber wall.

6. Clip the anode cap (Figure 9, #2) back into the CRT.

7. Replace the top.

8. Replace the card cage.

9. Replace the back panel.

10. Replace the front panel.

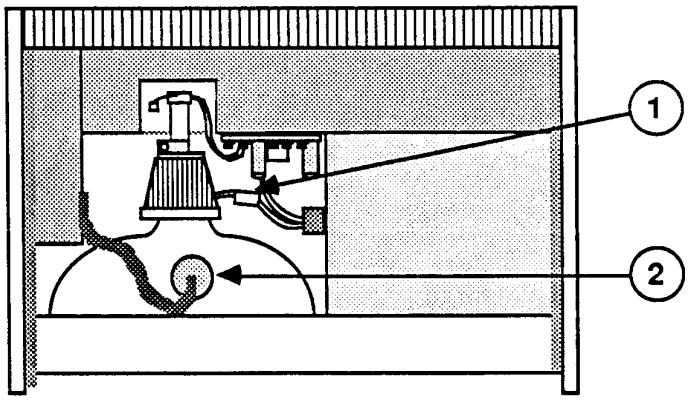


FIGURE 9

DISPOSING OF THE CATHODE-RAY TUBE (CRT)

WARNING: Remember that a CRT can implode unless it is devacuumed. Putting a defunct CRT into a trash receptacle without devacuuming it can endanger other people.

Materials Required

Thick cardboard box large enough to conceal the CRT
Large, sharp diagonal cutters
Large pliers
Duct tape
Safety goggles
Gardening gloves
12-inch square of cloth or heavy paper

Devacuuming the CRT

1. Put on the safety goggles.
2. In the side of the box about six inches from the bottom, cut or drill a hole just large enough to accommodate the very tip of the CRT.
3. Place the CRT inside the box with the tip of the neck protruding through the hole, and tape the box flaps down with duct tape (Figure 10).

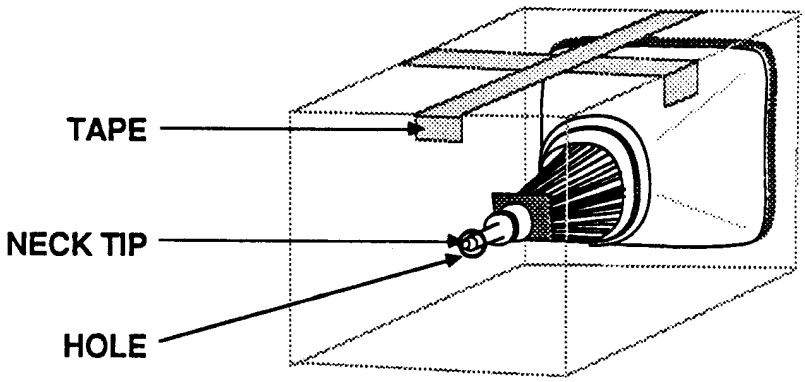


FIGURE 10

WARNING: Only the very tip of the CRT neck should be protruding through the hole in the box. The box must not have any other openings.

4. Put on the gloves.

5. Pull off the black plastic guide located at the end of the CRT neck. Using the diagonal cutters, carefully clip off the connector pins on the end of the CRT neck.

6. Tape the piece of cloth or paper onto the box (Figure 11, #1) so that it forms a veil over the opening (Figure 11, #2) but allows your hand access to the tip of the CRT. The veil's purpose is to catch the bits of glass that may fly during the following step.

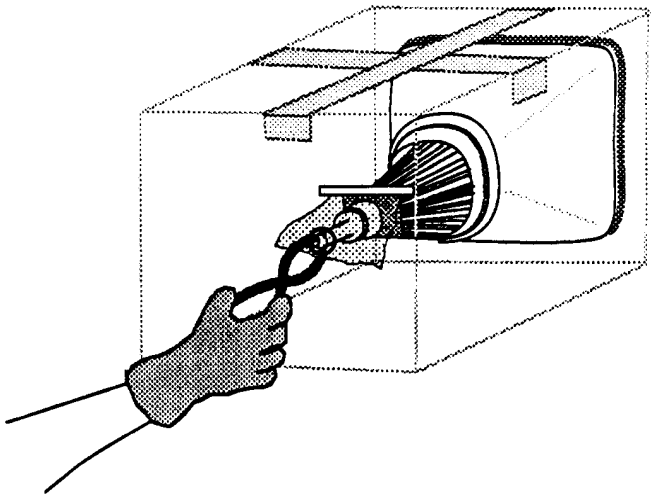


FIGURE 11

7. Make sure no one is standing nearby. Place the pliers under the veil, stand to one side, and look away while you use the pliers to snip off the exposed tip of the CRT.

   WARNING: Do not look directly at the box when cutting off the tip!

   You will probably hear a rush of air entering the CRT when the CRT vacuum breaks--but even if you don't, the procedure is complete if the inner space of the CRT is clearly visible through the opening created by the removed tip.

apple computer

Lisa Technical Procedures

Section 4

Video Adjustments

Contents:

CAUTION: BEFORE PERFORMING THESE ADJUSTMENTS, REVIEW THE SAFETY PROCEDURES IN THE VIDEO TAKE-APART TECHNICAL PROCEDURE.

apple computer

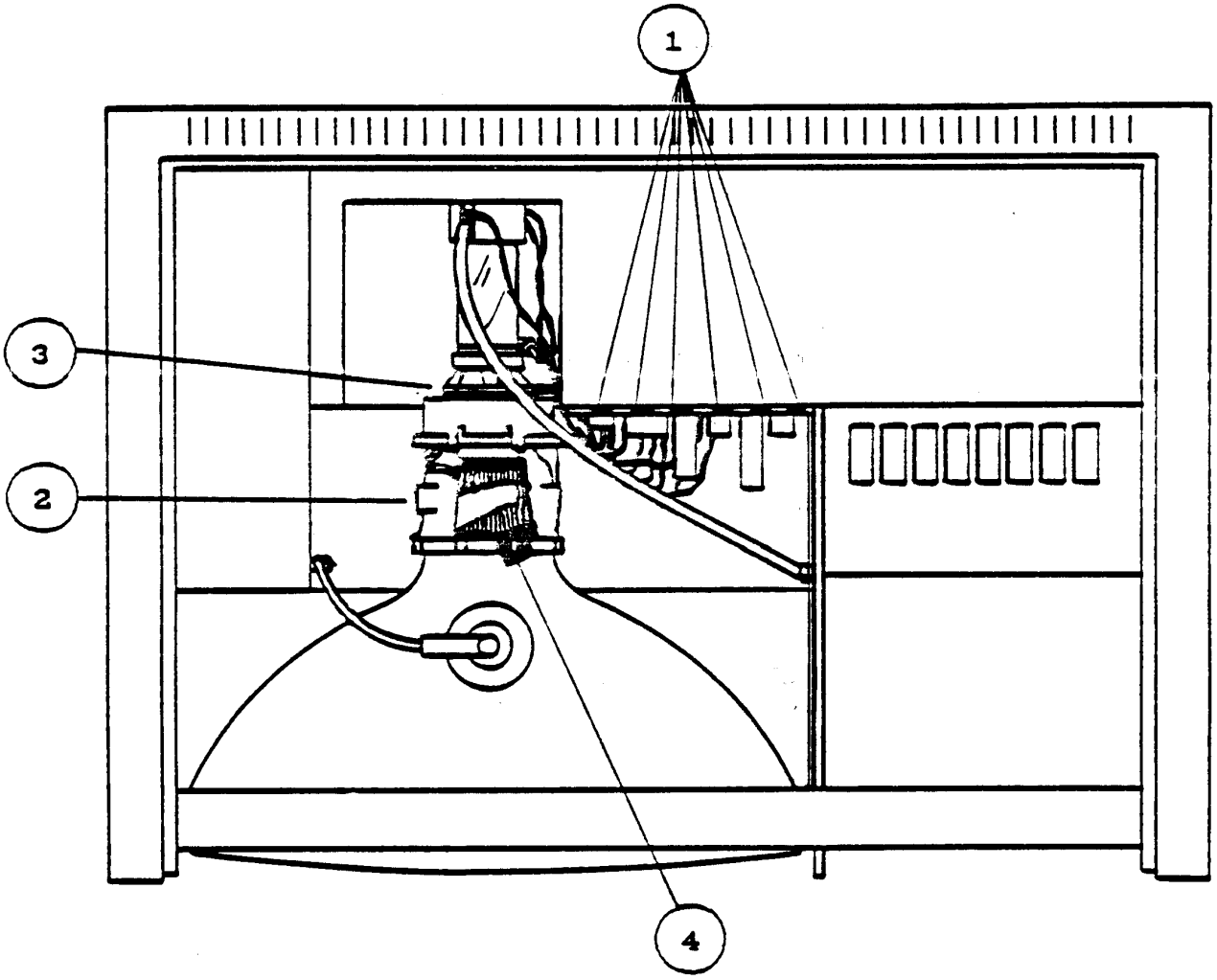


Figure 1

apple computer

INTRODUCTION

Before you sell or install a Lisa, you should inspect it at your shop to make sure, first, that it works, and second, that the video functions are properly adjusted. The video adjustments can slip during shipping, and, except for brightness and focus (at the upper rear of the Lisa, above the power cord socket), and contrast (software-controlled through the Preferences window), customers have no access to the controls. The controls are inside the Lisa video assembly, near high voltage areas, where we cannot allow customers to go. So if anything goes amiss during shipping, you will have to correct it for the customer. You will also need to perform the video adjustments if you replace the CRT assembly, the flyback transformer, or the video board.

There are four major types of adjustment: the video board potentiometers (Figure 1, #1), and the CRT yoke, centering rings, and magnets (Figure 1, #2, 3, and 4). Using an alignment graticule etched with centering marks, which you can lay over the screen, you will make all four adjustments by matching a video grid pattern to the graticule.

CRT's used in the final production model will have yokes with plastic collars; these collars have spokes on which you can fit magnets. Alpha (and some Beta) Test CRT's will not have collars, and to add magnets to them you will have to use Funtak (available at Gemco, Woolworth's, etc.) or an equivalent adhesive.

TOOLS AND EQUIPMENT NEEDED

LisaTest Diskette (P/N 682-0002)
Alignment graticule (P/N 652-3520)
Diagonal cutters ("dikes")
Medium Phillips screwdriver with insulated handle and shaft
Medium or small flatblade screwdriver with insulated handle and shaft
Safety goggles with closed side panels
Long rubber gloves with fingertips cut out
Adjustment magnets (P/N 652-4520)
Glue: Torque Seal, Glyptol or equivalent

IMPORTANT: All screwdrivers used in video work should have insulated handles and shafts. If you cannot find screwdrivers with insulated shafts, you can make them by putting a double layer of shrink tubing on the shaft of a normal screwdriver with insulated handle.

apple computer

ACCESSING THE VIDEO ASSEMBLY AND THE TEST PATTERNS

NOTE: In this and the following sections, we will give you directions for using mouse commands rather than keyboard commands. However, the keyboard can always be used instead of the mouse if you prefer it. To find the appropriate keyboard command, look to the right of the icon you are selecting. You will see the Apple symbol with a number or letter next to it. Press the **APPLE** key (on pre-release keyboards this was **COMMAND**) along with the number or letter shown next to the Apple symbol, and the Lisa will act as if you had selected the icon with the mouse.

IMPORTANT: Since the picture may expand and change position slightly as the Lisa warms up, you should let it warm up for 10 - 15 minutes before you adjust it.

1. Make sure power is off. Remove the front and rear panels from the Lisa.

2. Remove the card cage and unscrew and remove the top panel.

3. Replace the card cage and the front and rear panels.

4. Insert the LisaTest diskette into drive 1.

5. Turn on the Lisa by pushing the ON-OFF button, and, when you hear the first click, hit any key (except CAPS LOCK). This interrupts the automatic startup sequence and lets you specify the startup drive.

6. Use the mouse to select the icon for drive 1.

7. If the Lisa was cold, **allow it to warm up for 10-15 minutes.**

8. Examine the Lisa picture for the problems listed in the Summary of Video Adjustments (next page).

If there are no problems, do not continue with these procedures.

9. If you need to adjust the video functions, pull down the Options menu and choose "Check".

10. From the Check window, select the icon for a grey screen and click in the "OK" box. Then, when the next window appears, click in the OK box again. Now the screen will be a uniform grey.

apple computer

SUMMARY OF VIDEO ADJUSTMENTS

Problem	Correction
Screen dark.	Brightness, contrast.
Letters on screen look smudged, appear to have "shadows".	Turn down contrast trimpot.
Bent or distorted lines on crosshatch pattern or edges of picture.	Adjust magnets on yoke.
Entire picture tilted (rotated around center).	Adjust yoke.
"Shadow band" visible at left side of screen.	Horizontal Phase Adjustment.
Picture is too far to one side of the screen.	Horizontal Phase Adjustment.
Vertical distortions or distortions of scale from one part of the screen to another.	Adjust Width, Height, Vertical Linearity trimpots and centering rings.
Vertical and horizontal lines not perpendicular.	Make sure yoke is pushed fully forward on CRT neck.

apple computer

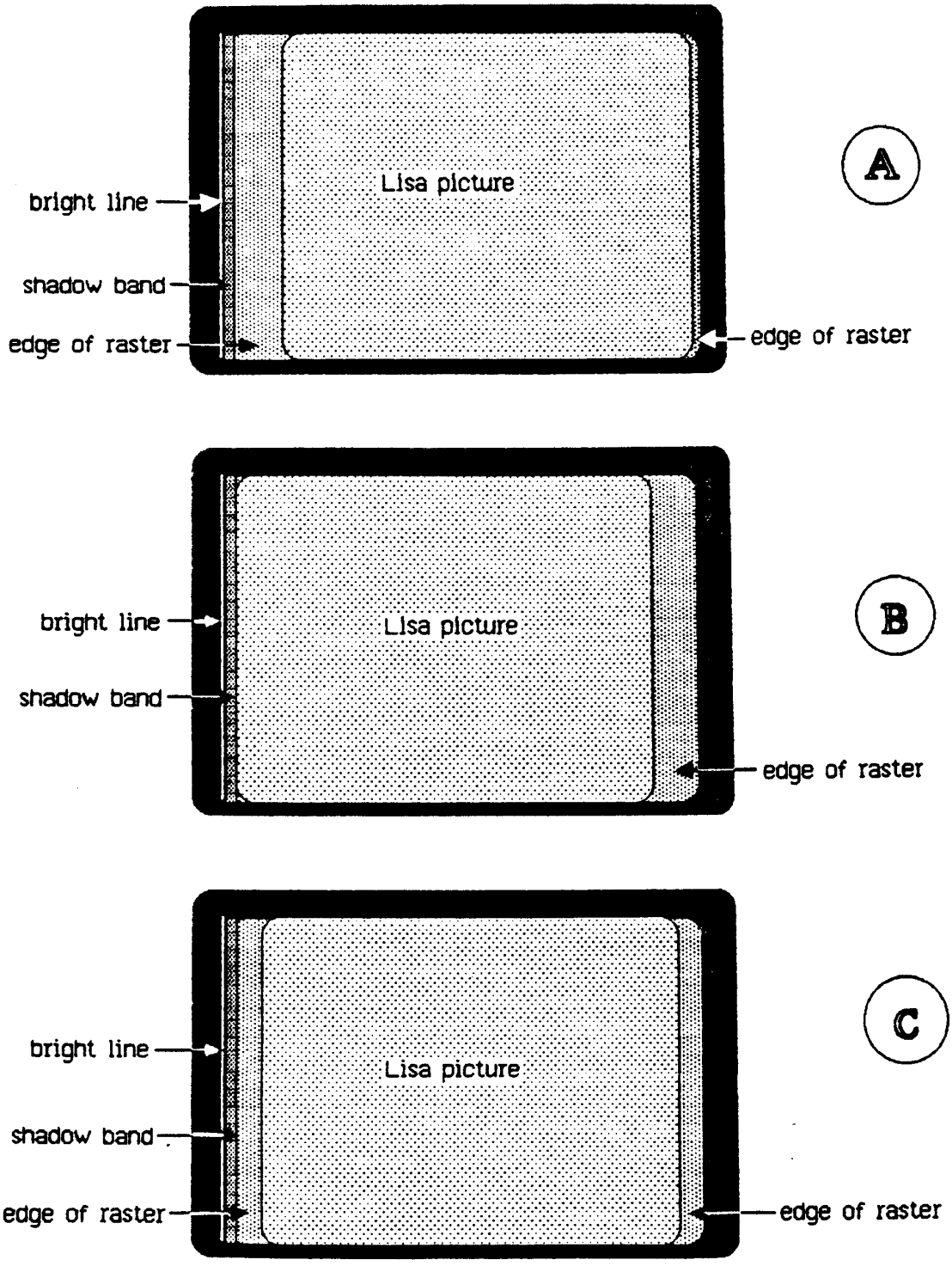


Figure 2

apple computer

HORIZONTAL PHASE ADJUSTMENT

If the Lisa picture is not properly centered in the raster (illuminated field on the screen), there will be a slight distortion at the left edge of the picture, in the form of a narrow band that is slightly darker than the rest of the screen. By adjusting the Horizontal Phase trimpot, you can move the picture outside the area of distortion ("shadow band") and center it in the undistorted part of the raster.

1. Remove all metal objects from your hands and arms. Put on the safety goggles to protect your eyes. Put on the rubber gloves to protect your hands from scratches. Keep one hand in your pocket or behind your back during these adjustments.

2. Turn up the brightness control on the back of the Lisa as far as it will go. (If the picture becomes distorted, turn down the brightness until it resumes normal shape.) Note that the Lisa picture is slightly smaller than the raster (illuminated field on the screen), so that the edges of the raster can now be seen around the picture.

3. Find the Horizontal Phase trimpot on the top of the video board and use it to move the picture all the way to the right (Figure 2A).

4. At the extreme left side of the raster you will see a bright line. To the right of the bright line is a vertical band of shadow (about 1/16 inch wide) slightly darker than the rest of the raster edge. (See Figure 2A. If you cannot see the shadow band, use the Horizontal Phase trimpot to move the picture left, until it reaches the bright line. You should be able to see the shadow then.)

5. Using the trimpot, move the left edge of the picture flush with the right edge of the shadow band (see Figure 2B, #1).

6. Now observe the space between the right edge of the picture and the right edge of the raster (Figure 2B, #2). Use the Horizontal Phase trimpot to move the picture halfway through that space (see Figure 2C).

7. Put a small drop of the specified glue on the trimpot, to hold it in place. Be careful not to cover up the name of the trimpot or the resistor number (e.g., R34, R22).

apple computer

BRIGHTNESS AND CONTRAST ADJUSTMENTS

1. Turn down the brightness control on the back of the Lisa until the raster just disappears and only the Lisa picture is visible.

2. Find the contrast trimpot (CONT) on the top of the video board. Turn the contrast trimpot to the maximum setting that does not distort the shape of the screen. If this causes the edges of the raster to become visible again, turn down the brightness control on the back of the Lisa until the raster is invisible again.

3. Turn down the contrast until the screen looks right. Then turn it down just a little more, so that the screen looks slightly darker than you would want it for actual use.

4. Put a small drop of the specified glue on the contrast trimpot, to hold it in place. Be careful not to cover up the name of the trimpot.

These are the proper hardware settings for brightness and contrast. From this point on, the contrast of the screen should be changed only by using the Preferences menu.

apple computer

CALLING UP THE VIDEO CROSSHATCH PATTERN

The rest of the video adjustments require that you match a crosshatch pattern on the CRT screen to an alignment graticule placed over the screen. To call up the video crosshatch pattern from LisaTest, use the following procedure.

1. If the grey test screen is still displayed, first hit any key to return to the "desktop". Then click in the box that says "OK", and the box will disappear.

2. Next, pull down the Options menu and choose "Check". From the "Check" window choose the crosshatch icon and click "OK". When the Note screen appears, read the note and then click "OK". The crosshatch pattern will then appear on the screen. (To return to the desktop, press any key.)

3. Place the alignment graticule (Figure 3) on the Lisa screen. Note that for each crosshatch line there are three marks on the graticule: the middle mark is the ideal setting, the two outer marks define the tolerance. Always try to get as close as possible to the ideal mark, as the adjustments will probably shift somewhat after you make them.

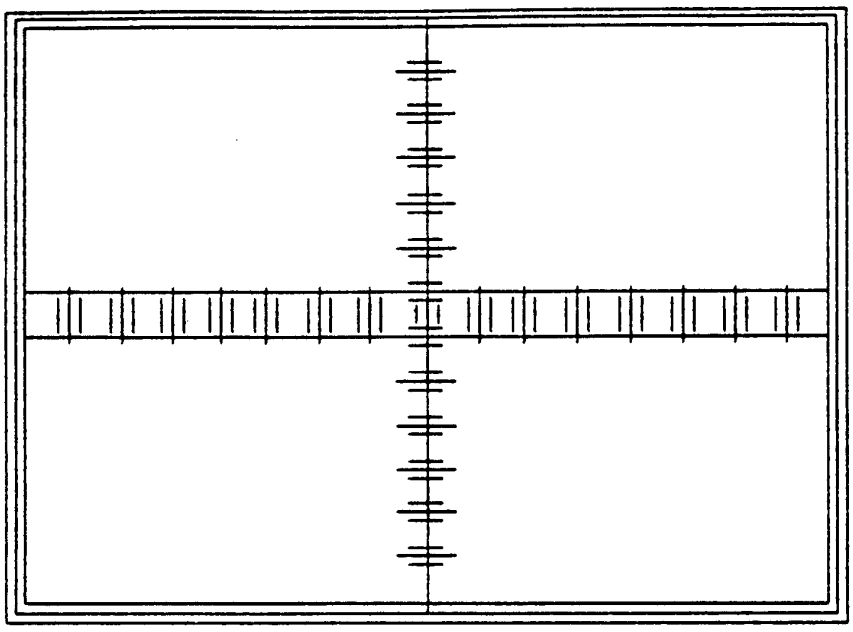


Figure 3

apple computer

YOKE ADJUSTMENT

The yoke affects the orientation of the picture on the physical screen: if you rotate the yoke, the entire picture rotates around its center. (Turning the yoke does not affect the shape or focus of the picture, only its orientation.) If the center vertical of the crosshatch pattern is not parallel to the graticule's center vertical, adjust the yoke as follows.

1. Remove all metal objects from your hands and arms. Put on the safety goggles to protect your eyes. Put on the rubber gloves to protect you from scratches in case you draw your hand out quickly. Keep one hand in your pocket or behind your back during these adjustments.

2. With a medium or small flatblade screwdriver, carefully loosen the yoke clamp screw (Figure 4, #1). Rotate the yoke by gripping it on the plastic section near the centering rings, until the center vertical of the crosshatch is parallel to the center vertical on the graticule.

3. Make sure the yoke is pushed fully forward on the CRT neck; then carefully tighten the screw on the yoke clamp: it should be tight enough to prevent the yoke from turning, but not so tight as to crack the tube.

   IMPORTANT: If the yoke is not pushed forward sufficiently, the vertical and horizontal lines of the crosshatch pattern will not be perpendicular to each other.

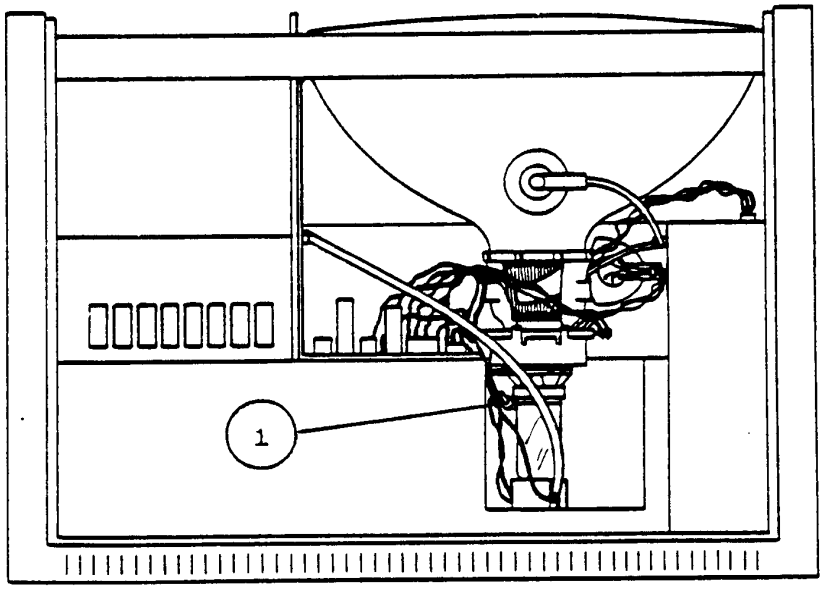


Figure 4

apple computer

HEIGHT, WIDTH, VERTICAL LINEARITY TRIMPOTS AND CENTERING RINGS

By adjusting the video board height, width, and vertical linearity trimpots in combination with the centering rings, you should be able to make the crosshatch pattern fit within the graticule's tolerance markings. You may notice curves or bends in the pattern at various points; don't worry about them at this point. You can correct for such distortions by adding small magnets to the yoke collar (see next section).

The rings are magnets that control the position of the picture on the screen. Each time you adjust a trimpot, you will have to recenter the picture using the rings, because the trimpots affect the centering. It is easier to recenter the picture after each trimpot adjustment than to wait until all adjustments are made. The following has proved to be the easiest and most efficient method for making these adjustments.

1. Using yoke and centering rings, make sure the center vertical on the video crosshatch is parallel to the center vertical on the graticule, and within the tolerance markings.

2. Using the Width trimpot, adjust the picture until the left and right borders are within graticule tolerance.

3. Recenter the picture using the rings and yoke, if necessary; use the center vertical as your guide.

4. Adjust the upper and lower borders of the picture to graticule tolerance using the Height trimpot. Readjust width and recenter picture if necessary.

   NOTE: You will probably see some slight distortion at the upper and lower right corners. Don't worry about this; you will correct for it later.

5. Check the height, width, centering and orientation of the picture against the graticule again. Repeat steps 1-4 if necessary.

6. Adjust the Vertical Linearity trimpot so that the horizontal lines of the crosshatch pattern are within graticule tolerance.

7. Readjust height and recenter picture if necessary. (The vertical linearity adjustment will affect height and centering.) If you did have to readjust height or centering, then recheck vertical linearity and readjust if necessary. Then recheck height and centering.... et cetera. These controls affect each other, so they must be adjusted and readjusted in this way.

apple computer

8. Step away from the unit and look away for a moment. Then inspect the picture again. Readjust if necessary.

9. If you see bent or distorted lines in the crosshatch pattern, adjust the magnets on the yoke (see next section). If not, put a small drop of the specified glue on the rings and one on each trimpot, to hold them in place. Be careful not to cover up the name of the trimpot or the resistor number (e.g., R34, R22).

MAGNET ADJUSTMENTS

After adjusting the picture as well as you can with the trimpots and rings, examine the crosshatch pattern for any distortions: curves or bends in the lines can be corrected by placing magnets around the yoke.

The magnets come in four strengths, according to the following color code:

yellow	=	5 gauss
red	=	7 gauss
blue	=	11 gauss
green	=	15 gauss

On yokes with spokes, simply place the magnet on the appropriate spoke and rotate the magnet until the distortion is corrected. If your weakest magnet is too strong for the correction you need, cut pieces off it with the dikes until it is the proper strength.

To apply magnets on spokeless yokes, put a small piece of magnet in a wad of Funtak. Find the spot on the yoke corresponding to the distorted area of the crosshatch, and stick the magnet on.

NOTE: To apply magnets to the bottom of the yoke, you may need to rotate the yoke so that the area is accessible. To do this, loosen the yoke collar screw and rotate the yoke as far as necessary. When finished, rotate the yoke back to normal position and retighten the screw.

Once you have adjusted the magnets, use a drop of the specified glue to hold each in place. Then recheck the trimpot adjustments. When you are satisfied with the adjustments, put a small drop of the specified glue on the rings and one on each trimpot. Be careful not to cover up the name of the trimpot or the resistor number (e.g. R34, R22).

apple computer

FINISHING UP

Turn off the Lisa. Let it sit in your shop overnight, to give the glue time to dry. In the morning, turn it on, let it warm up for 10 to 15 minutes, and check it with the alignment graticule to make sure that the adjustments have held.

apple computer

Lisa Technical Procedures

Section 5

Diagnostics

Contents:

apple computer

apple computer

INTERPRETING THE BOOT ROM

On power-up, the Lisa will automatically perform a self-test using the program in its boot ROM. As the CRT warms up (approximately 30 seconds after power-up), the monitor will display 4 icons representing the CPU, I/O, memory, and expansion cards as they are being tested. Each icon will be highlighted in sequence as the boot ROM checks them.

The boot ROM diagnostics are an overview of the system. If the system passes, you can use LisaTest for further testing. If one of the cards is faulty, its icon will be presented on the screen with an "X" through it. The testing will stop. You should try to reseat the board and power-up again. If you get that error message again, swap out the board.

USING LISATEST

NOTE: IN ORDER TO USE THE LISATEST DISKETTES, THE LISA MUST HAVE TWO MEMORY BOARDS INSTALLED.

1. If the Lisa is turned on, turn it off by pressing the on-off button once.

2. Power up the Lisa.

3. When you hear the first click, (when the four boot ROM icons are on the screen but have not all been checked off yet), press SPACEBAR.

   A startup menu with disk drive 1, 2, and ProFile icons will appear on the screen.

4. Insert the LisaTest diskette in drive 1.

5. Select the disk drive 1 icon.

6. Select CONTINUE.

   The diskette boots and the Lisa displays a page of instructions.

   (You can return to the instructions by selecting "Hints" from the options menu.)

7. To access the options menu hit any key or use the mouse to pull down the options menu.

apple computer

SETTING DIAGNOSTIC CONTROLS

Here you can change how a test is run, that is, once or continuously. You would select continuously to find intermittent errors.

1. Select Set Diagnostic Controls from the options menu.

   The defaults are," run once" for the diagnostic tests and "do not print error messages to printer."

2. To return to the menu bar and therefore the capability of accessing the options menu, select the CANCEL icon.

RUNNING A COMPLETE SYSTEM CHECK

You would use this selection if you have no idea what is causing an error.

1. Select "Run Complete System Check" from the options menu.

   NOTE: The first few tests will require input from the user. Follow the instructions displayed on the screen.

RUNNING INDIVIDUAL TESTS

NOTE: It is possible to select the icons by using the keyboard or the mouse. To use the keyboard, hold down the "Apple" key while pressing the letter or number indicated at the right of the icon you want to select.

1. Select "Check" from the options menu.

   Lisa now displays the icons for the diagnostics.

2. Selecting the test.

   1) Select the icon for the test you are interested in, and

   2) Select "OK". (Selecting "Cancel" would return you to options.)

apple computer

BRIEF DESCRIPTIONS OF TESTS

KEYBOARD verifies the keyboard interface and the operation of all keys. To run this test the "CAPS LOCK" key should be in the up position

This diagnostic requires some input from the user. This includes:

1. The user has to select "OK" to the note asking you to avoid pressing any keys when you unplug and plug in the keyboard.

2. Unplug and plug-in the keyboard on request from the diagnostic. This request will appear after you have selected "OK" for the note asking you to avoid pressing any keys when you unplug and plug in the keyboard.

3. Enter each key individually as it is pointed to by the cursor. Do this carefully. If you hear an error tone you may have depressed an incorrect key. In order to correct this error, depress the key until the arrow goes to the next key. If a wrong key is depressed more than two times the diagnostic assumes the keyboard has failed. To avoid having to complete the entire test after you have received the failure message, press the ON-OFF switch once and the keyboard failure message is displayed. Click "OK." Press the ON-OFF switch again to return to options.

   Note: Do not touch the mouse while running the keyboard test.

   Note: The "CAPS LOCK" key must be depressed twice (i.e., it must be first locked down and then released) while testing the keys (this is indicated by the arrow).

MOUSE The mouse test is comprehensive and exceedingly sensitive. If the mouse passes the first two subtests you can conclude that the mouse is good. After running these two tests, simultaneously depress the "APPLE" and "." (on the alphanumeric part of the keyboard) to terminate the mouse test.

apple computer

Button test For the button subtest read all of the instructions on the screen before holding down the mouse button. When the button is held down you will receive a "please release the mouse button" message. Follow these instructions. Be sure to wait for the commands to be displayed before acting. Otherwise, the test will assume the mouse has failed.

Basic movement For the basic movement subtest it is only important that you move the cursor so that it touches the four corners of each of the two rectangles. If you do this, the mouse will pass. Note, the coordinates which are displayed in the upper right corner of the screen need not exactly reflect the coordinates displayed at the corners of the rectangles.

Note: Do not depress any keys while running the mouse test.

LOWER DRIVE (The options menu will display "Upper Drive" if you have LisaTest in the lower drive.) The disk drive tests verify the operation of both disk drives by testing that certain parameters are within specifications (e.g., the motor speed). It also verifies the diskette/disk drive operation with a complete diskette surface test. This test takes a while so have patience.

DOT MATRIX verifies the functions of the dot matrix printer. This test requires user input. The last part of the test takes 6 minutes. Simultaneously depress the "APPLE" and "." (on the alphanumeric part of keyboard) to terminate the printer test.

The printer should be on and in select mode when you respond to the LisaTest question concerning the port off which the printer is running. Next, select "Run." The first three steps after you select run can be confusing. Here is what you should do.

1. Place the paper at top of form and turn the printer off.

2. Select "CONTINUE."

   You will receive a technical difficulties message. On a good printer this is supposed to happen.

3. Turn on the printer and select "CONTINUE."

apple computer

Now you can proceed with step 4 displayed on the CRT.

If the printer stops and displays an "experiencing technical difficulties message" at the Electronic Vertical Format (EVFU) test, select "CONTINUE." This does not necessarily mean the printer is bad. If you receive other such messages, keep selecting "CONTINUE" until the test is complete.

Attached you will find a copy of the printer test. Compare it with the printout you receive from running the test.

DAISY WHEEL verifies the functions of the daisy wheel printer. You must use the tractor feed while running this test. This test requires user input. Be sure the printer switches are set correctly before you run the test. (See the Setup section of these procedures for correct switch settings.)

Early in the test you may receive an extended beep with the printed message "internal loop back test FAILED." If you do, wait for the alert message to be displayed, turn off the printer, turn it back on, and select "CONTINUE." The printer functions will then be exercised for the next 12 minutes. To terminate the printer test early, simultaneously depress the "APPLE" and "." (on the alphanumeric part of the keyboard).

Attached you will find a copy of the printer test. Compare it with the printout you receive from running the test.

CPU verifies the logic on the CPU. It verifies the operation of the boot ROM, the memory management unit of the CPU board, and the video timing circuitry.

MEMORY tests all the RAM chips in both memory boards and identifies the size and location of memory in the Lisa. The memory board test takes about five minutes so have patience.

IOBOARD verifies the operation of the floppy diskette controller, serial and parallel ports, and the keyboard/mouse interface.

PROFILE verifies the Lisa/Profile communication and the RAM buffer, it checks the status block and does a block scan.

CROSSHATCH is the grid used for video adjustments. As

in the Lisa Video Adjustments procedure.

GRAY is also used for video adjustments.

PARALLEL INTERFACE CARD requires a loopback plug to work. Dealers and Service Representatives are not expected to test this module.

BACKUP LISATEST is the LisaTest copy facility.

```
 A P P L E   D O T  M A T R I X  P R I N T E R. (Rev 1.7)

Carriage return test, LF and not LF included.
...This line is printed with CR only.
...These two lines use the CR and LF mode.
     They should each be on a separate line.

Print methods test.
     This line should appear after you click Continue a second time.

Print direction test.
   This line should come out left-to-right,       - (bidirectional test)
   and this line should come out right-to-left.   - (bidirectional test)
   This line should come out left-to-right,       - (bidirectional test)
   and this line should come out right-to-left.   - (bidirectional test)
   This line should come out left-to-right.       -(unidirectional test)
   This line should come out left-to-right.       -(unidirectional test)
   This line should come out left-to-right.       -(unidirectional test)
   This line should come out left-to-right.       -(unidirectional test)

Select control test.
...DC1 and DC3 effective test.
...DC1 and DC3 ineffective test.

Left margin test.
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _ ` a b c d e f g
 f e d c b a ` _ ^ ] \ [ Z Y X W V U T S R Q P O N M L K J I H G F E D C B A

Line spacing test.
Base
        ..................................................
                  1111111111222222222233333333344444444
        12345678901234567890123456789012345678901234567
        ..................................................

Paper direction on line feed test.
  1. Written 1st           1        1
  2. Written 5th           2        2
  3. Written 6th           3        3
  4. Written 2nd           4        4
  5. Written 3rd           5        5
  6. Written 8th           6        6
  7. Written 7th           7        7
  8. Written 4th           8        8
  9. Written 9th           9        9
 10. Written 10th (last).  0        0

Alignment test.
H HH H H  Left>Right and Right>Left alignment.          HH  H H HHH H
H HH H H  Check alignment of H edges within one dot.    HH  H H HHH H

Special characters for all languages.
Language  Hex-Code >   23  24  40  5B  5C  5D  5E  60  7B  7C  7D  7E
--------               --  --  --  --  --  --  --  --  --  --  --  --
U.S.A.                 #   $   @   [   \   ]   ^   `   {   |   }   ~
U.K.                   £   $   @   [   \   ]   ^   `   {   |   }   ~
GERMANY                #   $   §   Ä   Ö   Ü   ^   `   ä   ö   ü   ß
FRANCE                 £   $   à   °   ç   §   ^   `   é   ù   è   ¨
ITALY                  £   $   §   °   ç   é   ^   ù   à   ò   è   ì
SWEDEN                 #   $   @   Ä   Ö   Å   ^   `   ä   ö   å   ~
SPAIN                  £   $   §   ¡   Ñ   ¿   ^   `   °   ñ   ç   ~

Print pitch test.
```

5.9

```
Proportional print.   .ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
                      1234567890!@#$%^&*()-_=+[{]};:,.<>/?
PICA (80).            . ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
                       1234567890!@#$%^&*()-_=+[{]};:,.<>/?
ELITE (96).           . ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
                       1234567890!@#$%^&*()-_=+[{]};:,.<>/?
Compressed.           .ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
                      1234567890!@#$%^&*()-_=+[{]};:,.<>/?
SPECIAL (120). ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
                      1234567890!@#$%^&*()-_=+[{]};:,.<>/?
SPECIAL (72).         .ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
                      1234567890!@#$%^&*()-_=+[{]};:,.<>/?
SPECIAL (144).        .ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
                      1234567890!@#$%^&*()-_=+[{]};:,.<>/?
```

...Double width.

```
Proportional print. ABCDEFGHIJKLMNOPQRSTUVWXYZab#
PICA (80). ABCDEFGHIJKLMNOPQRSTUVWXYZa#
ELITE (96). ABCDEFGHIJKLMNOPQRSTUVWXYZabcdef#
Compressed. ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxy#
SPECIAL (120). ABCDEFGHIJKLMNOPQR#
SPECIAL (72). ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopq#
SPECIAL (144). ABCDEFGHIJKLMNOPQRSTUVWXYZ#
```

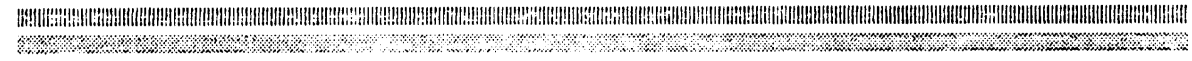
Proportional print with dots between characters set.

```
6   1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _ `
    a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
5   1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _ `
    a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
4   1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _ `
    a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
3   1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _ `
    a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
2   1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _ `
    a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
1   1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [ \ ] ^ _ `
    a b c d e f g h i j k l m n o p q r s t u v w x y z { | } ~
```

Bit image graphics test.

...Scale IIII

Bit Mapped Characters



Proportional #1 Bit Mapped Characters

PICA (80) Bit Mapped Characters

ELITE (96) Bit Mapped Characters

Compressed Bit Mapped Characters

SPECIAL (120) Bit Mapped Characters

SPECIAL (72) Bit Mapped Characters

Proportional #2 Bit Mapped Characters

Down-loaded character set test.

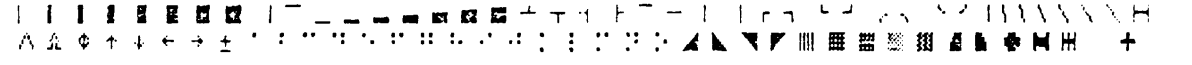
...Standard character set.

```
 !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOP
QRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
```

...Down-loaded character set, 1-to-8 bits.

5.10

```
 !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOP
QRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
```



```
Tabs test.
...Set and clear all tabs test.
         1111111111222222222233333333334444444444555555555566666666667777777777888888888999999
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234
 A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A  A
  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B  B
   C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C  C
...Selectively clear tabs test.
         1111111111222222222233333333334444444444555555555566666666667777777777888888888999999
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234
 abcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabc
    abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc
 abcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabc
 abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc   abc
 _1_  _2_  __3__  _4__  _5__  _6_  __7__  __8__  _9__  _10
 ONE  TWO  THREE  FOUR  FIVE  SIX  SEVEN  EIGHT  NINE  TEN

Cancel line command test.

The line between this and the header was cancelled.

Print enhancement test.
Bold off. This line is written with BOLD turned on. Bold off again.
Underline is off. This line will be underlined.  Underline is off again.

Zero  slashed/not slashed test.
...These zeros are printed slashed:  0 0 0 0 0 0 0 0 0 0 0 0
...These are printed not slashed:    0 0 0 0 0 0 0 0 0 0 0 0

Backspace test.  APPLE  should be underlined.
           These characters require backspacing: = : 0 0 0 a

Repeat function command test.
...Character repeat test.      . 12345678901234567890123456789012345678901234567890
   A will be repeated 10 times: AAAAAAAAAA
   B will be repeated 40 times: BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
   C wiill be repeated 18 times: CCCCCCCCCCCCCCCCCC
   D will be repeated  5 times: DDDDD
   E will be repeated  2 times: EE
...Dot column repeat test.      .  /     /        /  /
   Repeat column for  25 times:
   Repeat column for  70 times:
   Repeat column for 140 times:
   Repeat column for 165 times:
   Repeat column for 300 times:
...Dot addressing test..  H  H     H   H   H   HH   H    H  H        H
                          H  H     H   H   H   HH   H    H  H        H

Electronic Vertical Format Unit (EVFU) test.
...Expect a form feed after this line is printed.
```

5.11

Date: 3-Jan-1998

MEMO

To: Mr. Jones
From: Your Favorite Company
Subject: Payment

Regarding your letter dated June 12, 1977 , your check was mailed Nov 23, 1981 . Please wait 3 weeks from this date.

Signed,
Your fiend

5.12

```
  A P P L E  -  D A I S Y    W H E E L     P R I N T E R (Rev  1.3)

Software Version  1.6

DIP Switch 1: 11100111     DIP Switch 2: 10010000     DIP Switch FRONT PANEL: 00100001          1 = CLOSED     0 = OPEN

Internal loop back test PASSED

|!"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[•]©_°abcdefghijklmnopqrstuvwxyz§¶†¯`ţç{\}´¨¨¡¿ÄÖÜÅÑÆäöüåñéûèàîðæıçß¬•
Printer busy.
Auto line feed selected.
Printer in CHECK mode.
** OPERATOR ATTENTION REQUIRED **
Twintellect character sequence selected.

Print direction.
   Bidirectional test.
  This line should come out left-to-right        (Bidirectional test).
  ...and this line should come out right-to-left.(Bidirectional test).
  This line should come out left-to-right        (Bidirectional test).
  ...and this line should come out right-to-left.(Bidirectional test).
   Unidirectional test.
  This line should come out left-to-right.       (Unidirectional test).
  This line should come out left-to-right.       (Unidirectional test).
  This line should come out left-to-right.       (Unidirectional test).
  This line should come out left-to-right.       (Unidirectional test).


Paper direction on a line feed test.
   Full line feed test.
  1. Written 1st.              1      1
  2. Written 5th.              2      2
  3. Written 6th.              3      3
  4. Written 2nd.              4      4
  5. Written 3ed.              5      5
  6. Written 8th.              6      6
  7. Written 7th.              7      7
  8. Written 4th.              8      8
  9. Written 9th.              9      9
 10. Written 10th.             0      0

   1/2 line feed test.
  1. Written 1st.  2. Written 5th.
  3. Written 6th.  4. Written 2nd.
  5. Written 3ed.  6. Written 8th.
  7. Written 7th.  8. Written 4th.
  9. Written 9th.  10. Written 10th (last).   0 9 8 7 6 5 4 3 2 1  1 2 3 4 5 6 7 8 9 0


Enhancement test.

   Bold test.
Bold off.  This line is written with BOLD turned on.  Bold off again.
```

5-13

This entire line is written with BOLD1 turned on.
This entire line is written with BOLD2 turned on.
This entire line is written with BOLD3 turned on.
This entire line is written with BOLD4 turned on.

Underscore test.
Underscore is off. This line will be underlined. Underscore is off again.
This entire line is written with Underscore turned on. ABCDEFGHIJKLMNOP
ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
1234567890!@#$%^&*()- =+[{]};:,.<>/?

Shadow test.
Shadow is off. This line will be shadowed. Shadow is off again.
This entire line is written with Shadow turned on. ABCDEFGHIJKLMNOP
ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
1234567890!@#$%^&*()-_=+[{]};:,.<>/?

No Print test.
No Print is off. No Print is off again.
This password: should not be printed.

Backspace test. APPLE should be underlined.
Special made characters follow:- ? ö ● ø ä
123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuv
This line is printed using 1/120 backspace.

Carriage return test, LF (line feed) and not LF included.
...This line is printed with CR mode only.
...These two lines use the CR and LF mode.
They should each be on a separate line.

Left margin test.
1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W
1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W
1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W
1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W

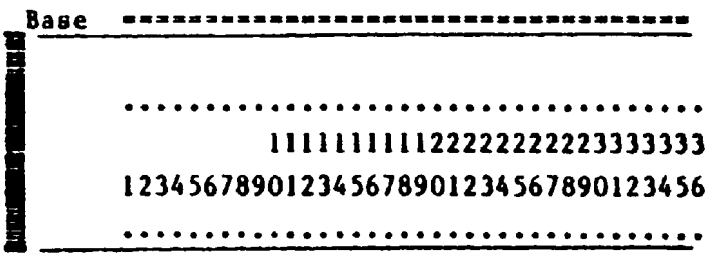
Horizontal tab stop test.

AAABBBCCCDDDEEEFFFGGGHHHIIIJJJKKKLLLMMMNNNOOOPPPQQQRRRSSSTTTUUUVVVWWWXXXYYY

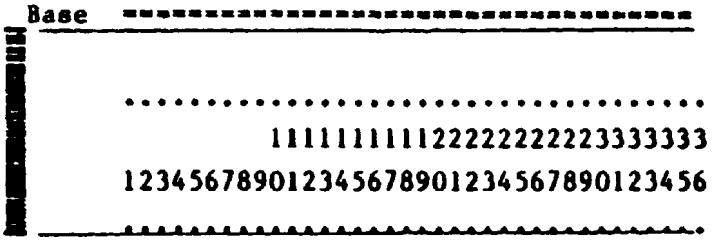
Tabs test.
...Set and all clear test.
11111111112222222222333333333344444444445555555555666666666677777777778888888888999999
12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345
A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A A
B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B B
C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C C
...Selectively clear tab test.
11111111112222222222333333333344444444445555555555666666666677777777778888888888999999
12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345
abcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabca
abc abc abc abc abc abc abc abc abc abc abc abc abc abc abc a
abcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabcabca
abc abc abc abc abc abc abc abc abc abc abc abc abc abc abc abc
1 2 3 4 5 6 7 8 9 10
ONE TWO THREE FOUR FIVE SIX SEVEN EIGHT NINE TEN

5.14

Vertical spacing test.



Alternate vertical spacing test.



Right margin and auto CR/LF Test.

123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[\]^_`abcdefghijklm

Bell test.

5-15

```
Absolute horizontal tab test.
 AAAAABBBBBCCCCCDDDDDEEEEEFFFFFGGGGGHHHHHIIIIIJJJJJKKKKKLLLLLMMMMMNNNNNOOOOOPPPPPQQQQQRRRRR
 RRRRRQQQQQPPPPPOOOOONNNNNMMMMMLLLLLKKKKKJJJJJIIIIIHHHHHGGGGGFFFFFEEEEEDDDDDCCCCCBBBBBAAAAA
Alternate absolute horizontal tab test.
AAAAABBBBBCCCCCDDDDDEEEEEFFFFFGGGGGHHHHHIIIIIJJJJJKKKKKLLLLLMMMMMNNNNNOOOOOPPPPPQQQQQRRRRR
RRRRRQQQQQPPPPPOOOOONNNNNMMMMMLLLLLKKKKKJJJJJIIIIIHHHHHGGGGGFFFFFEEEEEDDDDDCCCCCBBBBBAAAAA


Relative horizontal motion test.
 13579;=?ACEGIKMOQSUWY[]_acegikmoq pnljhfdb`^\ZXVTRPNLJHFDB@><:86420


Graphic modes.
  1/60 inch graphic mode.
```

```
  1/120 inch graphic mode.
```

```
   Graphics modes off.
```

```
Language test.

     United States !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
    Apple standard !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
Apple alternate WP !"£$%&'()*+,-./0123456789:;<=>?$ABCDEFGHIJKLMNOPQRSTUVWXYZ
            Sweden !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
           England !"£$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
            France !"£$%&'()*+,-./0123456789:;<=>?àABCDEFGHIJKLMNOPQRSTUVWXYZ
           Germany !"#$%&'()*+,-./0123456789:;<=>?$ABCDEFGHIJKLMNOPQRSTUVWXYZ
             Spain !"£$%&'()*+,-./0123456789:;<=>?$ABCDEFGHIJKLMNOPQRSTUVWXYZ
             Italy !"#$%&'()*+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ
DIFFERENCES IN       +                               +

     United States [\]^_`abcdefghijklmnopqrstuvwxyz{|}~/
    Apple standard [•]©¯°abcdefghijklmnopqrstuvwxyz§¶†™/
Apple alternate WP °çé^_ùabcdefghijklmnopqrstuvwxyzàòèì/
            Sweden ÄÖÅ^_`abcdefghijklmnopqrstuvwxyzäöå~/
           England [\]^_`abcdefghijklmnopqrstuvwxyz{|}~/
            France °ç§^_`abcdefghijklmnopqrstuvwxyzéùè¨/
           Germany ÄÖÜ^_`abcdefghijklmnopqrstuvwxyzäöüß/
             Spain ¡Ñ¿^_`abcdefghijklmnopqrstuvwxyz°ñç~/
             Italy [\]^_`abcdefghijklmnopqrstuvwxyz{|}~/
DIFFERENCES IN     ++++ +                            ++++

     United States !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
    Apple standard !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
Apple alternate WP !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
            Sweden !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
           England !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
            France !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
           Germany !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
             Spain !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
             Italy !"#$%&'()*+,-./0123456789:;<=>?@£ç{\}^¯¯¯¡¿ÄÖÜÅÑÆæßüåñéùèà
NO DIFFERENCES.

     United States [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
    Apple standard [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
Apple alternate WP [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
            Sweden [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
           England [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
            France [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
           Germany [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
             Spain [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
             Italy [•]©¯°îðæıçß¬•ijklmnopqrstuvwxyz§¶†™/
NO DIFFERENCES.
```

5-14

Vertical tab test.

1 2
2 3
3 4
4 5
5 6
6 7
7 8
8 9
9 10
10 11
11 12
12 13
13 14
14 15
15 16
16 17
17 18
18 19
19 20
20 21
21 22
22 23
23 24
24 25
25 26
26 27
27 28
28 29
29 30
30 31
31 32
32 33
33 34
34 35
35 36
36 37
37 38
38 39
39 40
40 41
41 42
42 43
43 44
44 45
45 46
46 47
47 48
48 49
49 50
50 51
51 52
52 53
53 54
54 55
55 56
56 57
57 58

5-18

Horizontal spacing test.
   Standard horizontal spacing test.
01234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678
0123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123

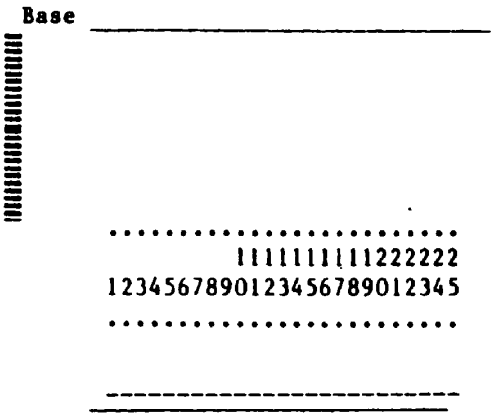
   Alternate horizontal spacing test.
012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678
012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123

Carriage print direction.
 This text line is printed using normal foward print mode.
   This text line is printed using special Backward print mode.
 This text line is printed using both Foward and Backward print modes.

 This line is printed using no escapement mode.

5-19

Vertical relative motion test.



5.20

apple computer

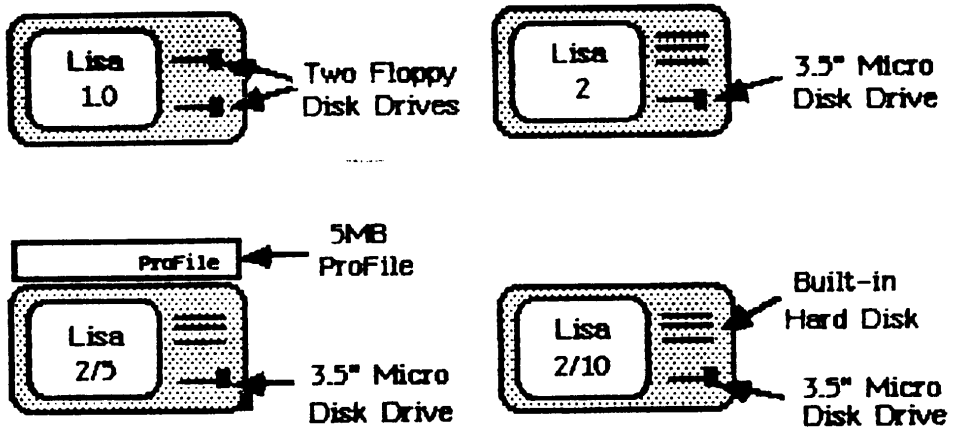
Lisa Technical Procedures

Section 6

Troubleshooting

Contents:

These procedures are appropriate for use with the Lisa 1.0, Lisa 2, Lisa 2/5, and Lisa 2/10. (See diagrams below to distinguish among the four Lisas.)



apple computer

LISA

TROUBLESHOOTING GUIDE

The Troubleshooting Guide has two parts: the Troubleshooting Table and the Procedures. If you have an idea where the problem lies go directly to the appropriate procedure. If you have no idea what the problem may be or if you were unsuccessful when using the procedures, use the Troubleshooting Table.

The table and the procedures will often list more than one "correction", "fix", or "probable failure" per symptom. Attempt the corrective actions in sequence, testing to see if you have fixed the problem after each one.

When a procedure gives a list of modules or boards that may be at fault, swap out the suspect module and replace it with a known good one from your spares kit. Then power-up and run the test again. If you still receive the error return the original module to the Lisa and try swapping out the next item on the list. Repeat the procedure until you do not receive the error. The module you replaced just prior to receiving no error was the faulty one.

apple computer

TROUBLESHOOTING TABLE

The Troubleshooting Table, which begins on the following page, examines the Lisa system sequentially, starting with the most central functions. The table is laid out in four columns across two facing pages and should be read from left to right. The four columns, from left to right, are as follows:

1) **TROUBLESHOOTING STEP:** what action you are to perform;

2) **EXPECTED INDICATIONS:** what is supposed to happen to the system as a result of the action you just performed, assuming everything is functioning correctly;

3) **PROBLEM INDICATION:** what might have happened to the system as a result of performing the Troubleshooting Step if the system is not functioning correctly; and,

4) **CORRECTIVE ACTION:** what you should do if you have experienced a problem (as noted in the previous column).

When using this table you will be working down the page through column one, looking at column two to see if everything is correct so far, and looking at columns three and four only if things are not occurring as expected.

The Troubleshooting Table will sometimes refer you to the procedures which follow the table.

apple computer

TROUBLESHOOTING STEP	EXPECTED INDICATIONS
1. If the Lisa is not already off, turn it off by using the soft power switch or program instructions.	1. ON/OFF Lamp should go out.
2. *a) Clear parameter memory by removing the back panel, then toggling SW1 on the I/O board to the OFF position. Do not remove the I/O board. b) Toggle it back after approximately 5 seconds. (NOTE: Clearing parameter memory erases all preference settings. This means that after repair, you will have to use the Office System to reinstate your preference settings.) c) Reinstall the back panel, making sure that the knobs are finger tight.	2. No indications expected.
3. Turn the Lisa on.	3. a) ON/OFF Lamp should come on. b) Lisa will be silent for about 3 seconds, and then will emit a single click. c) As the picture tube warms up (approximately 30 seconds after power on), the monitor should display 4 icons representing the CPU, I/O, Memory, and Expansion cards. Each icon will be highlighted in sequence as the Boot ROM Test checks them. d) If a card fails, you will hear error tones, and its icon will be displayed with a big "X" through it. e) Or, and error icon and error code will be displayed.

*** Lisa 2/10 I/O board does not have a switch.**

apple computer

PROBLEM INDICATIONS	CORRECTIONS
1. System may hang or the software may not be resident to perform the turn off function.	1. Go to System Hang Procedure.
2. No indications expected.	2. No corrective action.
3. a) The ON/OFF Lamp may not come on. b) The single "click" does not occur and/or unexpected tones are emitted. c) No picture after 30 seconds	3. a) Go to Power Repair Procedures. b) Push reset on back panel. If still does not boot go to Start-Up Repair Procedures. c) Go to Video Repair Procedures
d) Error Icon is displayed.	d) Go to Start-Up Icon Error Messages.
e) Error Icon and Error Code are displayed.	e) Go to Start-Up Error Codes.

TROUBLESHOOTING STEP	EXPECTED INDICATIONS
4. Insert LisaTest into the Drive.	4. The drive accepts and positions the heads on the diskette.
5. For Lisa 1, hold down APPLE and press 1 or 2 depending on which drive LisaTest is in. For Lisa 2, hold down APPLE and press 2.	5. Drive should load diagnostic and finally display instructions on the use of the diagnostic.

apple computer

PROBLEM INDICATIONS	CORRECTIONS
4. a) Diskette difficult or impossible to insert	4. Check that: a) Diskette is properly inserted. Lisa 1 - label top right side Lisa 2 - arrow toward drive * - If still have problem, insert diskette in other drive - If diskette is accepted in second drive, replace first drive - If cannot insert diskette in second drive you probably have a bad diskette. Otherwise both disk drives are bad.
b) Disk drive makes very unusual noises.	b) Replace drive.
5. a) Disk drive does not start loading, and you do not get the instruction page.	5. a) Use mouse to select "STARTUP FROM". If disk drive works, replace keyboard. - If neither the keyboard nor mouse works, turn off the Lisa, reseat the I/O board, and try procedure again. - Replace I/O board.
b) Error icon and code displayed.	b) Go to Start-Up Error Codes.
c) "Warning test cannot be loaded" displayed on screen.	c) Insert another known good Diagnostic Disk and rerun procedure. * - If unsuccessful, insert the diskette in the other drive and rerun this procedure. If the procedure works with this drive, then replace the drive it did not work with.

*** In Lisa 2.0 replace the disk drive.**

TROUBLESHOOTING STEP	EXPECTED INDICATIONS
6. Use the mouse to select "Run Complete System Check."	6. The Lisa will display the "TEST" and "CONTINUE" buttons and description of the test.
7. Using the mouse, select "CONTINUE".	7. Diagnostic sequentially tests each module.

apple computer

PROBLEM INDICATIONS	CORRECTIONS
	- If you still have the same problem, then replace memory board 2, and rerun this procedure. - If you still have the same problem, replace memory board 1.
d) Diskette does not boot completely, or the system may hang while booting.	d) Replace LisaTest diskette and rerun this procedure. - If unsuccessful, insert the diskette into the other drive and rerun this procedure. If the procedure works with this drive, then replace the drive it did not work with. - If you still have the same problem, replace the CPU board.
6. The mouse is properly connected to the Lisa but it does not work or the cursor is not displayed.	6. Go to Mouse Repair Procedures.
7. If a module fails its icon will be displayed.	7. Turn off the Lisa and replace the module.

apple computer

POWER REPAIR PROCEDURES

If you think the Lisa is having power problems, attempt the following fixes in the order presented.

1. Check cables and power cord.

2. Verify that front and back panels are installed securely so interlock switches are active.

3. Verify wall outlet is functioning.

4. Verify secure connection of ribbon cable from motherboard to softswitch/keyboard assembly.

5. Verify 2" ventilation space around the Lisa.

6. If system may have overheated (90 C or 195 F), unplug the Lisa and let it cool down for an hour.

7. Swap out the modules in the following order:
   a) power supply
   b) I/O board
   c) softswitch/keyboard assembly
   d) front interlock switch
   e) disk drive to card cage connector
   f) motherboard
   g) videoboard

apple computer

START-UP REPAIR PROCEDURES AND ERROR TONES

NOTE: Prior to diagnosing any problems in this section you should remove any expansion cards or other attachments from your Lisa and then push the reset button on the back. If the problem remains after the expansion cards have been removed, proceed to the troubleshooting chart below. If the problem disappears, replace the cards or attachments one at a time, restarting the system after each replacement. When the problem occurs again, the last module replaced is the module causing it.

SYMPTOM	PROBABLE FAILURE
Incorrect or no video, no "clicks", and no error tones.	- CPU - I/O - (Go to Video Repair Procedures) - Motherboard
No "clicks" and the display indicates that the Boot ROM Test found no problems.	- Speaker connections - I/O - Speaker
Blank screen and start-up "clicks."	- (Go To Video Repair Procedures)
Error tones with incorrect or no video.	
Lo	CPU Memory 1 Memory 2
Lo,Lo	Memory 2 CPU
Lo, Hi	Card Cage (swap out boards one at a time)
Lo, Lo, Hi	CPU
Lo, Hi, Lo	I/O

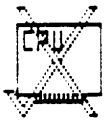
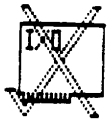
apple computer

SYMPTOM	PROBABLE FAILURE
Hi, Hi, Hi	Peripheral Card
Lo, Hi, Hi	Memory 1 Memory 2
Hi, Lo, Lo	Expansion Boards
Hi, Lo, Hi	Keyboard
Hi, Hi, Lo	Keyboard or Mouse disconnected

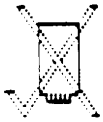
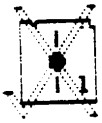
apple computer

START-UP ERROR ICONS

Swap out the module indicated by the Icon. If that is not successful swap out the subsequent modules listed here or look up the message code number in Start-up Error Codes.

ICON	MODULE AND OTHER POSSIBLE REPLACEMENTS
	- CPU
	- I/O
 	- Memory
	- Keyboard - I/O - Cable from motherboard to softswitch/keyboard assembly - Motherboard
	- Check Profile with LisaTest. If unsuccessful: - Replace profile - Replace I/O - Replace Motherboard

apple computer

ICON	MODULE AND OTHER POSSIBLE REPLACEMENTS
	- Replace Internal Hard Disk
	- Reseat Expansion Card - Try card in other slot - Swap in new card
Micro diskette  Floppy 5 1/4 inch diskette 	- Bad diskette * - If other drive works replace: - Drive - Cable - I/O - Motherboard - If other drive fails try back-up diskette - If still fails then replace: - I/O - Cable - Drive
 	- Insert diskette

* Lisa 2 has one micro diskette and Lisa 1 has two 5 1/4 inch floppy diskettes.

apple computer

APPENDIX D
START-UP ERROR CODES

NUMBER	PROBLEM	FIX
22	Unable to clamp diskette	Refer to start-up error messages for "bad diskette icon"
23	Unable to read diskette	" "
25	Unable to unclamp diskette	" "
38	No boot file on diskette	" "
39	Disk controller timeout	1. Replace I/O board 2. Replace CPU board 3. Replace Motherboard
40	MMU	Replace CPU board
41	CPU selection logic	Replace CPU board
42	Video circuitry	Replace CPU board
43	Parity circuitry	1. Replace CPU board 2. Replace Memory board 1 3. Replace Memory board 2 4. Replace Motherboard
44	NMI error	1. Replace CPU board 2. Replace I/O board 3. Replace Motherboard
45	BUS error	1. Replace I/O board 2. Replace CPU board 3. Replace Motherboard

NUMBER	PROBLEM	FIX
46	Address error	1. Replace CPU board 2. Replace Memory board 1 3. Replace Memory board 2
47	Exception	1. Replace CPU board 2. Replace Motherboard
48	Illegal instruction	1. Replace CPU board 2. Replace Memory board 1 3. Replace Memory board 2
49	1010 or 1111 trap	1. Replace CPU board 2. Replace Memory board 1 3. Replace Memory board 2
50	COPs VIA	1. Replace I/O board 2. Replace CPU board 3. Replace Motherboard
51	Parallel port VIA	1. Replace I/O board 2. Replace CPU board 3. Replace Motherboard
52	I/O board COPs	Replace I/O board
53	Keyboard COPs	1. Replace Keyboard 2. Replace I/O board 3. Replace Keyboard cable 4. Replace Motherboard
54	Clock error	Replace I/O board
55	RS232 port A	Replace I/O board
56	RS232 port B	Replace I/O board

apple computer

NUMBER	PROBLEM	FIX
57	Disk controller	1. Replace I/O board 2. Replace Disk Drive 3. Replace Disk Drive cables 4. Replace CPU board 5. Replace Motherboard
58	I/O board access	1. Replace I/O board 2. Replace CPU board 3. Replace Motherboard
59	I/O board COPs code	Replace I/O board
60	I/O or Keyboard error	1. Replace Keyboard 2. Replace I/O board 3. Replace Keyboard cable 4. Replace Motherboard
70 71	Memory data or Memory parity	Replace the Memory board specified by the icon displayed.
75	Boot failure	Refer to start-up error messages for the icon shown
80-85	Profile errors	Refer to start-up error messages for "bad profile icon"
90-93	Expansion card error	Refer to start-up error messages for "bad expansion card icon"

apple computer

VIDEO REPAIR PROCEDURES

WARNING: If you have never been taught how to adjust and replace the Lisa video modules do not attempt to do video repairs.

If you do not remember how to make one of the following video adjustments or replacements refer to the Video Adjustments job aid.

If the proposed procedures do not work see second note at the end of the table.

SYMPTOM	FIX
A sizzling noise coming from LISA	Replace power supply Adjust brightness Adjust contrast hardware Replace videoboard Replace flyback
Power supply trips (turns off & on)	Adjust brightness Adjust contrast hardware Replace power supply Replace videoboard Replace flyback
Blank screen and the CRT filament is NOT on when the LISA power is on	Check connections * Adjust brightness & contrast hardware Replace videoboard Replace CPU board Replace I/O board Replace power supply Replace flyback Replace CRT Replace motherboard
Blank screen and the CRT filament IS on when LISA power is on	Check connections * Adjust contrast hardware to middle range Replace power supply Replace videoboard Replace CRT Replace flyback Replace CPU board Replace motherboard

* See notes at the end of this table.

apple computer

SYMPTOM	FIX
CRT too bright or too dim	Power LISA off & on again. Adjust brightness & contrast pots (Do not adjust contrast via software until the brightness and contrast are adjusted.)
Unable to adjust brightness	Replace power supply Replace videoboard Replace CRT Replace CPU board
Unable to adjust contrast on the videoboard	Replace videoboard Check the connections * Replace CRT Replace flyback Replace CPU board Replace power supply
Unable to adjust contrast by the software	Replace I/O board Replace CPU board Replace videoboard Check keyboard with keyboard diagnostics Replace motherboard
Blurred screen	Adjust focus
Unable to adjust focus	Replace power supply Replace videoboard Replace CRT Check connections Replace flyback
Rolling screen	Adjust vertical hold
Unable to adjust vertical hold (Picture keeps flipping or will not flip at all)	Replace videoboard Replace CPU board Replace I/O board Replace motherboard

* See notes at the end of this table.

apple computer

SYMPTOM	FIX
Picture locked in wrong vertical position (i.e., picture begins in the middle of the screen)	Replace CPU board Replace videoboard Check connections * Adjust yoke
Small picture on CRT	Adjust height & width Adjust brightness & contrast Replace videoboard Replace flyback
Unable to adjust height with video pot	Replace videoboard Replace CPU board Replace I/O board Replace CRT
Unable to adjust width	Replace videoboard Replace CPU board Replace I/O board Replace CRT
Only a horizontal line on screen	Lower brightness & contrast Replace videoboard Replace CRT
Unable to adjust horizontal phase	Replace videoboard Replace CPU board Replace I/O board Replace flyback Replace motherboard Replace CRT
Unable to adjust vertical linearity	Replace videoboard Replace CPU board Replace I/O board Replace CRT Replace motherboard

* See notes at the end of this table.

apple computer

SYMPTOM	FIX
Scalloped picture	Adjust video controls Replace videoboard Replace power supply Replace flyback Make magnetic adjustments
Image on CRT not centered or not straight	Adjust yoke controls and magnets
Bad deflection	Replace videoboard Replace CRT
No horizontal stability (out of phase)	Replace videoboard Replace CPU board Replace I/O board Replace CRT
Double images	Replace CPU board Check connections
Inverse video	Replace CPU board
No video content	Replace CPU board Replace I/O board Replace videoboard Check connections
Smeared screen	Replace CPU board Replace I/O board Replace videoboard Check connections
Burns on screen	Replace CRT and turn down contrast, brightness, and software

Notes will be found on following page.

apple computer

* To "check connections" do the following:

1. Turn off the Lisa,
2. Unplug the Lisa power cord from the wall outlet,
3. Discharge the CRT and remove the flyback anode wire from the CRT,
4. Reconnect the flyback anode wire,
5. Remove and replace the video board,
6. Disconnect and reconnect each of the connectors that go to the video board,
7. Remove and replace the ground wire going from the back of the CRT to the chassis,
8. Make sure the connection on the back of the CRT tube is on snugly,
9. Remove and replace the power supply,
10. Remove the card cage,
11. Remove and reseat the CPU board,
12. Remove and reseat the I/O board,
13. Replace the card cage,
14. Plug the power cord into the Lisa, and
15. Plug the power cord into the wall outlet.

** If the Proposed Procedures do not work, check the video circuitry in the following order:

1. Adjust video controls,
2. Check the connections,
3. Replace the video board,
4. Replace the flyback,
5. Replace the CPU board,
6. Replace the I/O board,
7. Replace the power supply,
8. Replace the CRT, and
9. Replace the mother board.

apple computer

MOUSE REPAIR PROCEDURES

SYMPTOM	FIX
Cursor is not displayed	- Remove and reinsert mouse plug - Replace mouse
Moving the mouse or pushing its button does not work	- Remove and reinsert mouse plug - Try keyboard plug - If keyboard input is successful, replace mouse - If keyboard and mouse do not work replace: - I/O - CPU - Motherboard
Arrow moves vertically or horizontally only	- Remove and reinsert mouse plug - Replace mouse - Replace I/O

apple computer

SYSTEM HANG PROCEDURE

Sometimes, usually because of software failures, Lisa ignores all input. The usual solution is to turn off the system and start over. Since Lisa's on-off button is channeled through the computer, however, turning the system off is not always possible.

Note: The reset button, marked <!> on the back of the Lisa, is the backup technique for bringing the system back up when the software fails. Pushing the reset button clears the computer's memory and reinitiates the system startup procedures. **Anything on the desktop that has not been put away is lost during a reset.**

Before you push reset, make every effort to save any work that was on the desktop:

1. If the mouse is not working, try the alternative keyboard commands for putting away active documents. (See the manual for the software you are using.)
2. Try pressing the disk-release buttons, which should cause LISA to save all documents and release the diskettes.
3. Try turning the system off by pressing the on-off button once, which should trigger a series of verification and storage procedures.
4. If the system does not respond to any of these techniqes, you will not be able to recover whatever you were working on when the system failed.
5. Press the reset button once.
6. If the system starts up normally, you probably do not have a hardware problem. See Section E: Desktop Manager Reference Guide, under "Repair a Disk After a System Crash", in any tool manual.
7. If LISA displays an error message or error tones, refer to the Start-up Repair Procedures, Start-up Error Icons, and Start-up Error Codes.
8. If the LISA still "hangs," unplug the system from the wall outlet. Turn it back on, and listen carefully for error tones.

apple computer

PROFILE OR INTERNAL HARD DISK REPAIR PROCEDURES *

SYMPTOM	FIX
	NOTE: Do not attach or detach a Profile while either the Lisa or the Profile is on.
1. Profile or internal hard disk error icon is displayed while trying to boot.	a. Verify that your Profile or internal hard disk is properly attached. If Profile is not attached and it should be, follow this procedure: 1) Turn off the Profile. 2) Turn off Lisa. 3) Attach the Profile. 4) Turn on Profile 5) Turn on Lisa.
	b. If your Profile or internal hard disk is attached: 1) Turn off the Lisa. 2) Turn off the Profile. 3) Turn Profile back on. With internal hard disk turn on the Lisa. The disk's ready light flickers while it performs its self check. 4) The ready light comes on steadily after a successful self check. 5) If it does not, turn off and replace the hard disk. 6) Use LisaTest to test hard disk. 7) If hard disk fails, replace it. 8) If the hard disk passes LisaTest but still fails when the system is running, replace the hard disk.

* Hard disk refers to both the internal hard disk and the Profile.

apple computer

KEYBOARD REPAIR PROCEDURES

SYMPTOM	FIX
1. The CPU will receive no inputs from the keyboard.	a. Remove keyboard plug completely from its jack and reinsert. b. Try using the mouse. c. If "b" works, replace keyboard. d. If neither "b" nor "c" works, depress Lisa's soft power switch. e. If Lisa turns off, reseat the I/O board, CPU board, and motherboard and try again. If no improvement swap these boards in sequence one at a time. f. If Lisa does not turn off when you push the on/off button, go to the System Hang Procedure.
2. One or more of the keys on the keyboard does not seem to be working but the rest do.	a. Replace the keyboard.

apple computer

PRINTER REPAIR PROCEDURE

SYMPTOM	FIX
1. The printer misprints characters or will not print at all.	a. Check the connectors between the printer and Lisa for proper seating. b. Check the software to see if your printer is included in your configuration under "Preferences". c. If your configuration is correct and you have an Apple DWP: 1) Turn off the DWP and while pressing the form feed button, turn it back on. 2) Release the form feed button and the following text should print out. If it does not, repair or replace the printer.

DWP SELF CHECK PRINTOUT

```
+,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghij
,-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghijk
-./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghijkl
./0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghijklm
/0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghijklmn
0123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghijklmno
123456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghijklmnop
23456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghijklmnopq
3456789:;<=>?@ABCDEFGHIJKLMNOPQRSTUVWXYZ[®]©_°abcdefghijklmnopqr
```

apple computer

SYMPTOM	FIX
	d. If your configuration is correct and the printer is an Apple DMP: 1) Turn off the DMP, and while pressing the T.O.F. button turn it back on. 2) Release the T.O.F. button, and the following text should print out. If it does not, repair or replace the printer.

DMP SELF CHECK PRINTOUT

```
RSTUVWXYZ[\] _`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./012345
STUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456
TUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./01234567
UVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./012345678
VWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789
WXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789:
XYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789::
YZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789:;<
Z[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789:;<=
[\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789::<=>
\]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789:;<=>?
]^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789:;<=>?@
^_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789:;<=>?@A
_`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789:;<=>?@AB
`abcdefghijklmnopqrstuvwxyz{|}~ !"#$%&'()*+,-./0123456789:;<=>?@ABC
```

apple computer

DISK DRIVE REPAIR PROCEDURE

NOTE: IF THE THE DISK DRIVE PROBLEM IS NOT DESCRIBED IN THE TABLE BELOW GO TO THE FLOWCHART ON PAGE 6.32.

SYMPTOM	FIX
1. The diskette is difficult or impossible to insert	a) For Lisa 1 check that the disk label is on the top right side of the disk when inserted. For the Lisa 2 micro diskette, make sure the arrow on the diskette is pointing toward the drive. b) Try inserting the disk in the other drive if applicable. c) If you can properly insert the disk in the other drive, then replace the original drive. d) If you cannot properly insert the disk in either drive, then try another disk.
2. system displays a bad disk icon, and an error code on startup.	a) Go to the Start-Up Error Codes.
3. You got a bad disk icon and an error code while operating your system on line.	a) Go to the Office System Error Messages in Appendix A.
*4. While your system is running one disk drive operates but the other one does not.	a) Check the cable connections inside Lisa between the problem drive and the motherboard. b) If the drive ribbon cable is secured properly to the motherboard and the drive, then replace the problem drive. c) Replace I/O Board. d) Replace motherboard.

*** Lisa 2, 2/5, and 2/10 have only one disk drive.**

apple computer

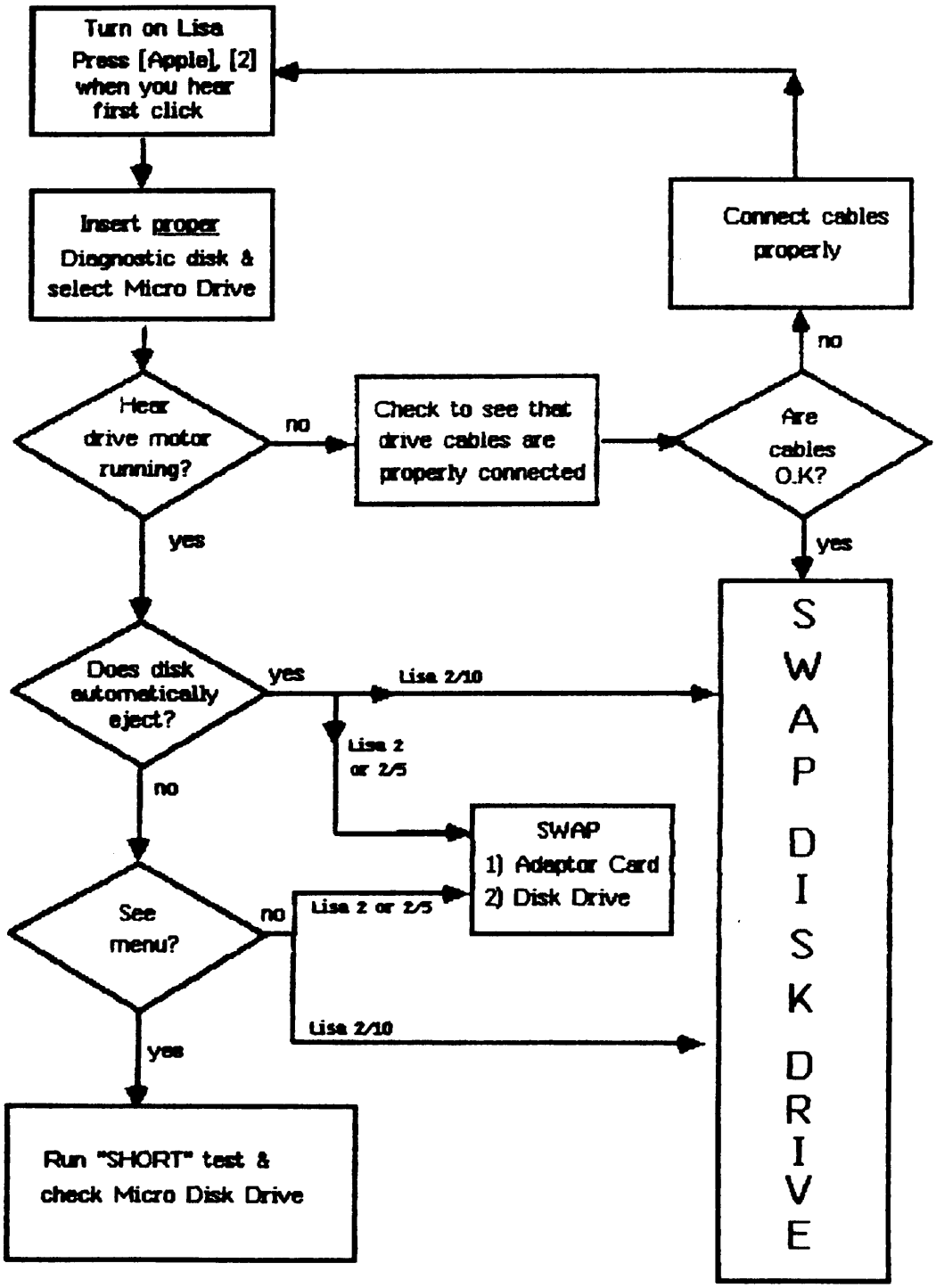
SYMPTOM	FIX
*5. While your system is running neither disk drive will operate but the keyboard and/or mouse seem to work.	a. Check the cable connections between the drives and the motherboard.
	b. Replace I/O board.
	**c. Replace motherboard.
6. While your system is running the disk will not eject.	a. Check to see if you can input from the keyboard, mouse, disk eject button or the soft on/off button.
	b. Go to the System Hang Procedure.
	**c. Try loading a disk into the other drive and then ejecting it.
	d. If "c" works, replace original drive, if not, replace I/O board.

*** Lisa 2, 2/5, and 2/10 have only one disk drive.**

**** For Lisa 2, remove the front cover and manually eject the disk. Then, follow the flowchart on page 6.32.**

apple computer

NOTE: Lisa must have two memory boards to use the Lisa Diagnostic diskette!



apple computer

APPENDIX A

OFFICE SYSTEM ERROR MESSAGES

This appendix contains a series of discussions covering the error messages generated by the Lisa Office System. The discussions are grouped into four general categories, with specific entries under each major heading. If you have encountered an error message, go to the specific entry mentioned in that message. If you think you may have a physical problem with your system, refer to Troubleshooting in this manual.

Disk Problems
- Insufficient Room on Disk
- Damaged Disk
- Difficulty Accessing Disk
- Disk Drive Problems

Document Problems
- Damaged Document
- Difficulty Opening Document
- Difficulty Saving Document

Tool Problems
- Tool Failure
- Difficulty Starting Tool
- Incompatible Version

System Problems
- Insufficient Memory
- System Restart
- Desktop State
- Difficulty Printing

apple computer

DISK PROBLEMS

INSUFFICIENT ROOM ON DISK

Many common desktop operations -- opening or saving documents, for example -- require a certain amount of free disk space. When your disks become crowded, you can make more room in several ways:

Discarding Obsolete Documents Discard obsolete documents by moving their icons to the Wastebasket. The last thing you discard from a disk stays in the Wastebasket -- and on the storage disk -- until something else from the same disk is also discarded or you choose the **Empty "Wastebasket"** item in the **Housekeeping** menu after discarding the documents. Sometimes the Lisa destroys objects in the Wastebasket if it needs the disk space. Usually, however, the space occupied by an object is not actually reclaimed until you have thrown away another object from the same disk or chosen Empty "Wastebasket" in the **Housekeeping** menu. Therefore, if you are discarding a group of documents in order to make more room on the disk, choose **Empty "Wastebasket"** from the **Housekeeping** menu afterward.

Moving Objects You can move some objects to a different storage disk. Do not duplicate the object, because that will not remove the copy from the original disk.

Repairing the Disk You can repair the disk, following the procedures in Section C, Troubleshooting, under Disk Repair in the Lisa 2 Owner's Guide.

Special Case If you are using LisaList, choose **Show Entire List** from the **List** menu.

If, after you have made more space on the disk that holds the document, the Lisa still indicates that there is not enough room on the disk, check the Status panel of the start disk window to verify that there is also space available on the startup disk.

DAMAGED DISK

The Lisa may tell you that one of your disks is "damaged." This could mean either that some of the information stored on the disk has been altered or that the disk itself is physically damaged.

First, repair the disk following the procedures in Section C, Troubleshooting, under Disk Repair in the Lisa 2 Owner's Guide. The repair process verifies that all information on the disk is usable and that the record of where things are stored on the disk surface matches the actual contents of the disk. Unreadable information may be altered or removed; the names of some documents may change.

If the Lisa is unable to repair the disk, either the disk or the disk drive probably has a physical problem. If the disk in question is a floppy try inserting it in another drive in the same Lisa or (for Lisa 1) or another Lisa (for Lisa 2). If the other drive has no trouble with the diskette, then there may be something wrong with the first disk drive. If the other drive cannot read the diskette either, then the disk may have suffered physical damage. Use a backup copy of the diskette.

DIFFICULTY ACCESSING DISK

First, try restarting the system: put away all open documents, and then turn the Lisa off and back on again. When the desktop returns, try again to access the disk.

If this procedure works, your system was probably in a temporary error condition caused by the interaction of different tools and documents.

If restarting the system doesn't solve the problem, the most likely cause is a damaged document, disk, or tool. If you are trying to access a document, see Damaged Document. If that discussion does not address your problem, see Damaged Disk, and then, as a last resort, Tool Failure and Disk Drive Problems.

DISK DRIVE PROBLEMS

Sometimes a mechanical failure in a disk drive results in errors that appear to come from your documents or disks. You can verify that the drive in question is working properly by trying the disk in the other drive or in another drive in another Lisa.

If you find that the disk drive and not the diskette is at fault, have the drive repaired and repair any disks that were used in the damaged drive. A faulty disk drive could have permanently damaged a disk. If this is the case, you'll need to use the backup copy of the disk.

DOCUMENT PROBLEMS

DAMAGED DOCUMENT

A document can be damaged in a number of ways. The disk on which the document is stored could be wearing out, for example, or the document may have been damaged during a power failure. Sometimes a software failure leaves a document unreadable.

First, restart the system if you have not already done so. Put away all documents, and then turn the Lisa off and on again. Try again to open the document.

If the document still won't open, try to duplicate the document and put the duplicate on a different disk. If this works, the original disk is probably not damaged. Try to open the copy. If the Lisa reports that the copy is also damaged, the document itself probably contains some inconsistent or unreadable information. The Tool could also be damaged. If you are using LisaList, repair the document with the LisaList repair facility.

If you cannot make a duplicate of the document, try to make a copy of the entire disk. Whether or not the copy procedure works, repair the original disk following the instructions in Section C, Troubleshooting, under Disk Repair in the Lisa 2 Owner's Guide. If you are using LisaList, you will probably have to repeat the LisaList repair procedure. Be sure to make a new backup of the list first.

If the document is still damaged after the disk is repaired, discard the document and replace it with a backup copy.

DIFFICULTY OPENING DOCUMENT

Check the status panel of the document's storage disk to see how much free space is left on the disk. If the number of free blocks is approaching 200 or fewer, see Insufficient Room on Disk.

If the disk contains adequate free space, your document or the tool used to create it could be damaged. See Damaged Document; see also Tool Failure.

DIFFICULTY SAVING DOCUMENT

Check the status panel of the document's storage disk to see how much free space is left on the disk. If you have saved an earlier version of the document, change the disk display to an alphabetical view, and see how many blocks the document required in its earlier version. Estimate how much space the document now needs, on the basis of whether you have added or removed information. If there is inadequate space available, see Insufficient Room on Disk.

If disk space is not the problem, or if you do not want to remove anything to make room on the storage disk, you may be able to save the document by setting it aside and then moving it to another disk. Because some tools will not let you move a document that has not been saved, you may not be able to use this technique.

Difficulty saving a document could also indicate a damaged document. See Damaged Document.

apple computer

TOOL PROBLEMS

TOOL FAILURE

Before you conclude that a tool is actually damaged, restart the system and try to repeat the failure. To restart the system, put away all documents, and then turn the Lisa off and on again. If the procedure works after a restart, the system was probably in a temporary error condition caused by the interaction of various tools and documents.

If the tool still fails, discard the working copy from your internal hard disk (or ProFile) and replace it with a duplicate of the master tool. If your dealer set up your startup disk, the working copies of all tools are stored in the folder labeled Tools on your startup disk. A diskette containing the master tool is stored in the manual that comes with each tool.

The calculator, the clock, the Preferences, and some of the printing routines are all part of the system software. If replacing the tool doesn't work, or if the problem was with this software in the first place, reinstall the system software on your startup disk. Instructions for reinstalling system software appear in Section C, Troubleshooting, under Procedure E, Disk Repairing and Reinstalling System Software in the Lisa 2 Owner's Guide.

DIFFICULTY STARTING TOOL

Check the status panel in the window of the disk that holds the tool and, if it is different, in the window of your startup device. If the number of free blocks is approaching 200 or fewer, see Insufficient Room on Disk.

If disk space is not the problem, see Tool Failure.

INCOMPATIBLE VERSION

From time to time, Apple releases updated versions of the Lisa software. If you buy an additional Lisa system more than six months after you bought your first Lisa System, the computers may come with different versions of the software. (If you have a support agreement, you will always have the most recent updates of all software.)

Old documents are usually compatible with new revisions of the tools. New documents, however, may not be compatible with old versions of the tools; and once you have worked on an old document with a more recent version of the tool, you may no longer be able to work on that document with the old tool. If the Lisa cannot work on a document because the tool and the document are incompatible, take the document to a Lisa that has a more recent revision of the tool. To find out the release date of a tool, display an alphabetical or chronological view of the folder in which the tool is stored.

apple computer

SYSTEM PROBLEMS

INSUFFICIENT MEMORY

Insufficient room in memory usually means either that too many documents are open on the desktop or that the document you are actually working on has gotten too big.

First, put away all documents with which you currently are not working, especially if the documents were created with a different tool from the one you are using.

If the Lisa still cannot perform the task, restart the system: put away all documents, and turn the Lisa off and on again. Then open only the document you want to work on, and try the operation again.

If you are using LisaList, try changing to a larger font or shrinking the document window.

If none of these techniques works, then your document is probably too big. Split it into two smaller documents if possible.

SYSTEM RESTART

Sometimes the Lisa Office System encounters an error condition that it cannot handle. In this case, the Lisa shuts down the desktop and starts over. If possible, any open documents are suspended in their current states so that you can continue where you left off after the system started again.

If the problem recurs, either your software or your hardware may be damaged.

Try reinstalling your system software and replacing the working copies of the tools you were using when the Lisa shut down the desktop. Instructions for reinstalling system software appear in Section C, Troubleshooting, under Disk Repair in the Lisa 2 Owner's Guide. If your dealer transferred the software to your startup disk, the working copies of all tools are stored in the folder labeled Tools. A diskette containing the master copy of the tool is stored in the manual that comes with each tool.

If the problem recurs after reinstalling your system software, your system hardware may need repair.

DESKTOP STATE

When you are using the Lisa Office System, pressing a disk-release button triggers a series of storage procedures. Before ejecting the diskette, the computer records the "desktop state" of the diskette. The desktop state includes a list of all documents from that disk that are currently on the desktop, the size and location of any open windows, all changes to the documents since they were last saved, and the current selection or insertion point in each open document.

If the Lisa is unable to save the desktop state for a disk, check the Status panel of the disk to see how much space is available. If you have several open documents and not much disk space left, see Insufficient Room on Disk for suggestions for making more room on the disk. Alternatively, you can put away some of the documents by choosing **Save & Put Away** from the **File/Print** menu or by clicking twice on the document's title bar icon. This way the Lisa has less information to record on the state of the desktop.

If disk space is not the problem, you may have a faulty disk drive. See Disk Drive Problems.

During a sudden power loss or an unexpected software failure, the normal power-down and disk-release procedures described above do not occur. The disks are left in an in-between state, which requires repair. See Section C, Troubleshooting, under Disk Repair in the Lisa 2 Owner's Guide.

Usually, losing the desktop state is not a problem. Simply open the disks yourself, and then open any documents you want to work on. However, you may have lost any work you have done since last saving your documents.

DIFFICULTY PRINTING

The Lisa can have difficulty printing a document for a number of reasons, from simple mechanical problems to software failures.

First, verify that the printer is turned on and that all connections are secure. See Section C, Troubleshooting, in the Lisa 2 Owner's Guide for a checklist of possible mechanical problems.

If your system setup checks out, the Lisa may have insufficient room in memory or insufficient free space on the startup disk. See Insufficient Memory and Insufficient Room on Disk.

If none of these strategies solves the problem either the tool you were using or your system software may have failed. See Tool Failure.

apple computer

APPENDIX B

OPERATING SYSTEM ERROR MESSAGES

Operating system error messages may help you find the problem, but always double-check using the usual troubleshooting procedures.

-6081	End of exec file input
-6004	Attempt to reset text file with typed-file type
-6003	Attempt to reset nontext file with text type
-1885	ProFile not present during driver initialization
-1882	ProFile not present during driver initialization
-1176	Data in the object have been altered by Scavenger
-1175	File or volume was scavenged
-1174	File was left open or volume was left mounted, and system crashed
-1173	File was last closed by the OS
-1146	Only a portion of the space requested was allocated
-1063	Attempt to mount boot volume from another Lisa or not most recent boot volume
-1060	Attempt to mount a foreign boot disk following a temporary unmount
-1059	The bad block directory of the diskette is almost full or difficult to read
-876	(from CLOSE_OBJECT) The file just closed. May be damaged or contain corrupted data because an I/O error occurred when writing a part of the file that was buffered by the file system
-696	Printer out of paper during initialization
-660	Cable disconnected during ProFile initialization
-626	Scavenger indicated data are questionable, but may be OK
-622	Parameter memory and the disk copy were both invalid
-621	Parameter memory was invalid but the disk copy was valid
-620	Parameter memory was valid but the disk copy was invalid
-413	Event channel was scavenged
-412	Event channel was left open and system crashed
-321	Data segment open when the system crashed. Data possibly invalid.
-320	Could not determine size of data segment
-150	Process was created, but a library used by program has been scavenged and altered
-149	Process was created, but the specified program file has been scavenged and altered
-125	Sepcified process is already terminating
-120	Specified process is already active
-115	Specified process is already suspended
100	Specified process does not exist
101	Specified process is a system process
110	Invalid priority specified (must be 1..225)
130	Could not open program file
131	File System error while trying to read program file
132	Invalid program file (incorrect format)
133	Could not get a stack segment for new process
134	Could not get a syslocal segment for new process
135	Could not get sysglobal space for new process

apple computer

136 Could not set up communication channel for new process
138 Error accessing program file while loading
141 Error accessing a library file while loading program
142 Cannot run protected file on this machine
143 Program uses an intrinsic unit not found in the Intrinsic Library
144 Program uses an intrinsic unit whose name/type does not agree with the Intrinsic Library
145 Program uses a shared segment not found in the Intrinsic Library
146 Program uses a shared segment whose name does not agree with the Intrinsic Library
147 No space in syslocal for program file descriptor during process creation
148 No space in the shared IU data segment for the program's shared IU globals
190 No space in syslocal for program file description during List_LibFiles operation
191 Could not open program file
192 Error trying to read program file
193 Cannot read protected program file
194 Invalid program file (incorrect format)
195 Program uses a shared segment not found in the Intrinsic Library
196 Program uses a shared segment whose name does not agree with the Intrinsic Library
198 Disk I/O error trying to read the intrinsic unit directory
199 Specified library file number does not exist in the Intrinsic Library
201 No such exception name declared
202 No space left in the system data area for Declare_Excep_Hdl or Signal_Excep
203 Null name specified as exception name
302 Invalid LDSN
303 No data segment bound to the LDSN
304 Data segment already bound to the LDSN
306 Data segment too large
307 Input data segment path name is invalid
308 Data segment already exists
309 Insufficient disk space for data segment
310 An invalid size has been specified
311 Insufficient system resources
312 Unexpected File System error
313 Data segment not found
314 Invalid address passed to Info_Address
315 Insufficient memory for operation
317 Disk error while trying to swap in data segment

apple computer

401 Invalid event channel name passed to Make_Event_Chn
402 No space left in system global data area for Open_Event_Chn
403 No space left in system local data area for Open_Event_Chn
404 Non-block-structured device specified in pathname
405 Catalog is full in Make_Event_Chn or Open_Event_Chn
406 No such event channel exists in Kill_Event_Chn
410 Attempt to open a local event channel to send
411 Attempt to open event channel to receive when event channel has a receiver
413 Unexpected File System error in Open_Event_Chn
416 Cannot get enough disk space for event channel in Open_Event_Chn
417 Unexpected File System error in Close_Event_Chn
420 Attempt to wait on a channel that the calling process did not open
421 Wait_Event_Chn returns empty because sender process could not complete
422 Attempt to call Wait_Event_Chn on an empty event-call channel
423 Cannot find corresponding event channel after being blocked
424 Amount of data returned while reading from event channel not of expected size
425 Event channel empty after being unblocked, Wait_Event_Chn
426 Bad request pointer error returned in Wait_Event_Chn
427 Wait_List has illegal length specified
428 Receiver unblocked because last sender closed
429 Unexpected File System error in Wait_Event_Chn
430 Attempt to send to a channel which the calling process does not have open
431 Amount of data transferred while writing to event channel not of expected size
432 Sender unblocked because receiver closed in Send_Event_Chn
433 Unexpected File System error in Send_Event_Chn
440 Unexpected File System error in Make_Event_Chn
441 Event channel already exists in Make_Event_Chn
445 Unexpected File System error in Kill_Event_Chn
450 Unexpected File System error in Flush_Event_Chn
530 Size of stack expansion request exceeds limit specified for program
531 Cannot perform explicit stack expansion due to lack of memory
532 Insufficient disk space for explicit stack expansion
600 Attempt to perform I/O operation on non I/O request
602 No more alarms available during driver initialization
605 Call to nonconfigured device driver
606 Cannot find sector on floppy diskette (disk unformatted)
608 Illegal length or disk address for transfer
609 Call to nonconfigured device driver

apple computer

610 No more room in sysglobal for I/O request
613 Unpermitted direct access to spare track with sparing enabled on floppy drive
614 No disk present in drive
615 Wrong call version to floppy drive
616 Unpermitted floppy drive function
617 Checksum error on floppy diskette
618 Cannot format, or write protected, or error unclamping floppy diskette
619 No more room in sysglobal for I/O request
623 Illegal device control parameters to floppy drive
625 Scavenger indicated data are bad
630 The time passed to Delay_Time, Convert_Time, or Send_Event_Chn has invalid year
631 Illegal timeout request parameter
632 No memory available to initialize clock
634 Illegal timed event id of -1
635 Process got unblocked prematurely due to process termination
636 Timer request did not complete successfully
638 Time passed to Delay_Time or Send_Event_Chn more than 23 days from current time
639 Illegal date passed to Set_Time, or illegal date from system clock in Get_Time
640 RS-232 driver called with wrong version number
641 RS-232 read or write initiated with illegal parameter
642 Unimplemented or unsupported RS-232 driver function
646 No memory available to initialize RS-232
647 Unexpected RS-232 timer interrupt
648 Unpermitted RS-232 initialization, or disconnect detected
649 Illegal device control parameters to RS-232
652 N-port driver not initialized prior to ProFile
653 No room in sysglobal to initialize ProFile
654 Hard error status returned from drive
655 Wrong call version to ProFile
656 Unpermitted ProFile function
657 Illegal device control parameter to ProFile
658 Premature end of file when reading from driver
659 Corrupt File System header chain found in driver
660 Cable disconnected
662 Parity error while sending command or writing data to ProFile
663 Checksum error or CRC error or parity error in data read
666 Timeout
670 Bad command response from drive
671 Illegal length specified (must = 1 on input)
672 Unimplemented console driver function

apple computer

673 No memory available to initialize console
674 Console driver called with wrong version number
675 Illegal device control
680 Wrong call version to serial driver
682 Unpermitted serial driver function
683 No room in sysglobal to initialize serial driver
685 Eject not allowed this device
686 No room in sysglobal to initialize n-port card driver
687 Unpermitted n-port card driver function
688 Wrong call version to n-port card driver
690 Wrong call version to parallel printer
691 Illegal parallel printer parameters
692 N-port card not initialized prior to parallel printer
693 No room in sysglobal to initialize parallel printer
694 Unimplemented parallel printer function
695 Illegal device control parameters (parallel printer)
696 Printer out of paper
698 Printer offline
699 No response from printer
700 Mismatch between loader version number and Operating System version number
701 OS exhausted its internal space during startup
702 Cannot make system process
703 Cannot kill pseudo-outer process
704 Cannot create driver
706 Cannot initialize floppy disk driver
707 Cannot initialize the File System volume
708 Hard disk mount table unreadable
709 Cannot map screen data
710 Too many slot-based devices
724 The boot tracks do not know the right File System version
725 Either damaged File System or damaged contents
726 Boot device read failed
727 The OS will not fit into the available memory
728 SYSTEM.OS is missing
729 SYSTEM.CONFIG is corrupt
730 SYSTEM.OS is corrupt
731 SYSTEM.DEBUG or SYSTEM.DEBUG2 is corrupt
732 SYSTEM.LLD is corrupt
733 Loader range error
734 Wrong driver is found. For instance, storing a diskette loader on a ProFile
735 SYSTEM.LLD is missing

apple computer

736	SYSTEM.UNPACK is missing
737	Unpack of SYSTEM.OS with SYSTEM.UNPACK failed
791	Configurable driver (CD) code file not executable
792	Could not get code space for the CD
793	IO error reading CD code file
794	CD code file not found
795	CD has more than 1 segment
796	Cound not get temporary space while loading CD
801	IO Result <> 0 on I/O using the Monitor
802	Asynchronous I/O request not completed successfully
803	Bad combination of mode parameters
806	Page specified is out of range
809	Invalid arguments (page, address, offset, or count)
810	The requested page could not be read in
816	Not enough sysglobal space for File System buffers
819	Bad device number
820	No space in sysglobal for asynchronous request list
821	Already initialized I/O for this device
822	Bad device number
825	Error in parameter values (Allocate)
826	No more room to allocate pages on device
828	Error in parameter values (Deallocate)
829	Partial deallocation only (ran into unallocated region)
835	Invalid s-file number
837	Unallocated s-file or I/O error
838	Map overflow: s-file too large
839	Attempt to compact file past PEOF
840	The allocation map of this file is truncated
841	Unallocated s-file or I/O error
843	Requested exact fit, but one could not be provided
847	Requested transfer count is <= 0
848	End of file encountered
849	Invalid page or offset value in parameter list
852	Bad unit number
854	No free slots in s-list directory (too many s-files)
855	No available disk space for file hints
856	Device not mounted
857	Empty, locked, or invalid s-file
861	Relative page is beyond PEOF (bad parameter value)
864	No sysglobal space for volume bitmap
866	Wrong FS version or not a valid Lisa FS volume
867	Bad unit number
868	Bad unit number
869	Unit already mounted (mount)/no unit mounted
870	No sysglobal space for DCB or MDDF
871	Parameter not a valid s-file ID
872	No sysglobal space for s-file control block
873	Specified file is already open for private access
874	Device not mounted
875	Invalid s-file ID or s-file control block
879	Attempt to postion past LEOF
881	Attempt to read empty file

apple computer

882 No space on volume for new data page of file
883 Attempt to read past LEOF
884 Not first auto-allocation, but file was empty
885 Could not update filesize hints after a write
886 No syslocal space for I/O request list
887 Catalog pointer does not indicate a catalog (bad parameter)
888 Entry not found in catalog
890 Entry by that name already exists
891 Catalog is full or is damaged
892 Illegal name for an entry
894 Entry not found, or catalog is damaged
895 Invalid entry name
896 Safety switch is on--cannot kill entry
897 Invalid bootdev value
899 Attempt to allocate a pipe
900 Invalid page count or FCB pointer argument
901 Could not satisfy allocation request
921 Pathname invalid or no such device
922 Invalid label size
926 Pathname invalid or no such device
927 nvalid label size
941 Pathname invalid or no such device
944 Object is not a file
945 File is not in the killed state
946 Pathname invalid or no such device
947 Not enough space in syslocal for File System refdb
948 Entry not found in specified catalog
949 Private access not allowed if file already open shared
950 Pipe already in use, requested access not possible or dwrite not allowed
951 File is already opened in private mode
952 Bad refnum
954 Bad refnum
955 Read access not allowed to specified object
956 Attempt to position FMARK past LEOF not allowed
957 Negative request count is illegal
958 Nonsequential access is not allowed
959 System resources exhausted
960 Error writing to pipe while an unsatisfied read was pending
961 Bad refnum
962 No WRITE or APPEND access allowed
963 Attempt to position FMARK too far past LEOF
964 Append access not allowed in absolute mode
965 Append access not allowed in relative mode
966 Internal inconsistency of FMARK and LEOF (warning)

apple computer

967 Nonsequential access is not allowed
968 Bad refnum
971 Pathname invalid or no such device
972 Entry not found in specified catalog
974 Bad refnum
977 Bad refnum
978 Page count is nonpositive
979 Not a block-structured device
981 Bad refnum
982 No space has been allocated for specified file
983 Not a block-structured device
985 Bad refnum
986 No space has been allocated for specified file
987 Not a block-structured device
988 Bad refnum
989 Caller is not a reader of the pipe
990 Not a block-structured device
994 Invalid refnum
995 Not a block-structured device
999 Asynchronous read was unblocked before it was satisfied
1021 Pathname invalid or no such entry
1022 No such entry found
1023 Invalid newname, check for '-' in string
1024 New name already exists in catalog
1031 Pathname invalid or no such entry
1032 Invalid transfer count
1033 No such entry found
1041 Pathname invalid or no such entry
1042 Invalid transfer count
1043 No such entry found
1051 No device or volume by that name
1052 A volume is already mounted on device
1053 Attempt to mount temporarily unmounted boot volume just unmounted from this Lisa
1054 The bad block directory of the diskette is invalid
1061 No device or volume by that name
1062 No volume is mounted on device
1071 Not a valid or mounted volume for working directory
1091 Pathname invalid or no such entry
1092 No such entry found
1101 Invalid device name
1121 Invalid device, not mounted, or catalog is damaged
1122 (from RESET_CATALOG) There is no space available in the process' local data area to allocate the catalog scan buffer
1124 (from GET_NEXT-ENTRY) There is no space available in the process' local data area to allocate the catalog scan buffer
1128 Invalid pathname, device, or volume not mounted
1130 File is protected; cannot open due to protection violation
1131 No device or volume by that name

apple computer

1132 No volume is mounted on that device
1133 No more open files in the file list of that device
1134 Cannot find space in sysglobal for open file list
1135 Cannot find the open file entry to modify
1136 Boot volume not mounted
1137 Boot volume already unmounted
1138 Caller cannot have higher priority than system processes when calling ubd
1141 Boot volume was not unmounted when calling rbd
1142 Some other volume still mounted on the boot device when calling rbd
1143 No sysglobal space for MDDF to do rbd
1144 Attempt to remount volume which is not the temporarily unmounted boot volume
1145 No sysglobal space for bit map to do rbd
1158 Track-by-track copy buffer is too small
1159 Shutdown requested while boot volume was unmounted
1160 Destination device too small for track-by-track copy
1161 Invalid final shutdown mode
1162 Power is already off
1163 Illegal command
1164 Device is not a diskette device
1165 No volume is mounted on the device
1166 A valid volume is already mounted on the device
1167 Not a block-structured device
1168 Device name is invalid
1169 Could not access device before initialization using default device parameters
1170 Could not mount volume after initialization
1171 '-' is not allowed in a volume name
1172 No space available to initialize a bitmap for the volume
1176 Cannot read from a pipe more than half of its allocated physical size
1177 Cannot cancel a read request for a pipe
1178 Process waiting for pipe data got unblocked because last pipe writer closed it
1180 Cannot write to a pipe more than half of its allocated physical size
1181 No system space left for request block for pipe
1182 Writer process to a pipe got unblocked before the request was satisfied
1183 Cannot cancel a write request for a pipe
1184 Process waiting for pipe space got unblocked because the reader closed the pipe
1186 Cannot allocate space to a pipe while it has data wrapped around
1188 Cannot compact a pipe while it has data wrapped around
1190 Attempt to access a page that is not allocated to the pipe

apple computer

1191 Bad parameter
1193 Premature end of file encountered
1196 Something is still open on device--cannot unmount
1197 Volume is not formatted or cannot be read
1198 Negative request count is illegal
1199 Function or procedure is not yet implemented
1200 Illegal volume parameter
1201 Blank file parameter
1202 Error writing destination file
1203 Invalid UCSD directory
1204 File not found
1210 Boot track program not executable
1211 Boot track program too big
1212 Error reading boot track program
1213 Error writing boot track program
1214 Boot track program file not found
1215 Cannot write boot tracks on that device
1216 Could not create/close internal buffer
1217 Boot track program has too many code segments
1218 Could not find configuration information entry
1219 Could not get enough working space
1220 Premature EOF in boot track program
1221 Position out of range
1222 No device at that position
1225 Scavenger has detected an internal inconsistency symptomatic of a software bug
1226 Invalid device name
1227 Device is not block structured
1228 Illegal attempt to scavenge the boot volume
1229 Cannot read consistently from the volume
1230 Cannot write consistently to the volume
1231 Cannot allocate space (Heap segment)
1232 Cannot allocate space (Map segment)
1233 Cannot allocate space (SFDB segment)
1237 Error rebuilding the volume root directory
1240 Illegal attempt to scavenge a non-OS-formatted volume
1295 The allocation map of this file is damaged and cannot be read
1296 Bad string argument has been passed
1297 Entry name for the object is invalid (on the volume)
1298 S-list entry for the object is invalid (on the volume)
1807 No disk in floppy drive
1820 Write-protect error on floppy drive
1822 Unable to clamp floppy drive
1824 Floppy drive write error
1882 Bad response from ProFile
1885 ProFile timeout error

apple computer

1998 Invalid parameter address
1999 Bad refnum
6001 Attempt to access unopened file
6002 Attempt to reopen a file which is not closed using an open FIB (file info block)
6003 Operation incompatible with access mode with which file was opened
6004 Printer offline
6005 File record type incompatible with character device (must be byte sized)
6006 Bad integer (read)
6010 Operation incompatible with file type or access mode
6081 Premature end of exec file
6082 Invalid exec (temporary) file name
6083 Attempt to set prefix with null name
6090 Attempt to move console with exec or output file open
6101 Bad real (read)
6151 Attempt to reinitalize heap already in use
6152 Bad argument to NEW (negative size)
6153 Insufficient memory for NEW request
6154 Attempt to RELEASE outside of heap

Operating System Error Codes

The error codes listed below are generated only when a nonrecoverable error occurs while in Operating System code.

10050 Request block is not chained to a PCB (Unblk_Req)
10051 Bld_Req is called with interrupts off
10100 An error was returned from SetUp_Directory or a Data Segment Routine Setup_IUInfo)
10102 Error > 0 trying to create shell (Root)
10103 Sem_Count > 1 (Init_Sem)
10104 Could not open event channel for shell (Root)
10197 Automatic stack expansion fault occurred in system code (Check_Stack)
10198 Need_Mem set for current process while scheduling is disabled SimpleScheduler)
10199 Attempt to block for reason other than I/O while scheduling is disabled (SimpleScheduler)
10201 Hardware exception occurred while in system code
10202 No space left from Sigl_Excep call in Hard_Excep
10203 No space left from Sigl_Excep call in Nmi_Excep
10205 Error from Wait_Event_Chn called in Excep_Prolog
10207 No system data space in Excep_Setup
10208 No space left from Sigl_Excep call in range error
10212 Error in Term_Def_Hdl from Enable_Excep
10213 Error in Force_Term_Excep, no space in Enq_Ex_Data

apple computer

10401 Error from Close_Event_Chn in Ec_Cleanup
10582 Unable to get space in Freeze_Seg
10590 Fatal memory parity error
10593 Unable to move memory manager segment during startup
10594 Unable to swap in a segment during startup
10595 Unable to get space in Extend_MMlist
10596 Trying to alter size of segment that is not data or stack (Alt_DS_Size)
10597 Trying to allocate space to an allocated segment (Alloc_Mem)
10598 Attempting to allocate a nonfree memory region (Take_Free)
10599 Fatal Disk error trying to read system code into memory
10600 Error attempting to make timer pipe
10601 Error from Kill_Object of an existing timer pipe
10602 Error from second Make_Pipe to make timer pipe
10603 Error from Open to open timer pipe
10604 No syslocal space for head of timer list
10605 Error during allocate space for timer pipe, or interrupt from nonconfigured device
10609 Interrupt from nonconfigured device
10610 Error from info about timer pipe
10611 Spurious interrupt from floppy drive #2
10612 Spurious interrupt from floppy drive #1, or no syslocal space for timer list element
10613 Error from Read_Data of timer pipe
10614 Actual returned from Read_Data is not the same as requested from timer pipe
10615 Error from open of the receiver's event channel
10616 Error from Write_Event to the receiver's event channel
10617 Error from Close_Event_Chn on the receiver's pipe
10619 No sysglobal space for timer request block
10624 Attempt to shut down floppy disk controller while drive is still busy
10637 Not enough memory to initialize system timeout drives
10675 Spurious timeout on console driver
10699 Spurious timeout on parallel printer driver
10700 Mismatch between loader version number and Operating System version number
10701 OS exhausted its internal space during startup
10702 Cannot make system process
10703 Cannot kill pseudo-outer process
10704 Cannot create driver
10706 Cannot initialize floppy disk driver
10707 Cannot initialize the File System volume
10708 Hard disk mount table unreadable
10709 Cannot map screen data
10710 Too many slot-based devices
10724 The boot tracks do not know the right File System version
10725 Either damaged File System or damaged contents
10726 Boot device read failed
10727 The OS will not fit into the available memory
10728 SYSTEM.OS is missing
10729 SYSTEM.CONFIG is corrupt

apple computer

10730 SYSTEM.OS is corrupt
10731 SYSTEM.DEBUG or SYSTEM.DEBUG2 is corrupt
10732 SYSTEM.LLD is corrupt
10733 Loader range error
10734 Wrong driver is found. For instance, storing a diskette loader on a ProFile
10735 SYSTEM.LLD is missing
10736 SYSTEM.UNPACK is missing
10737 Unpack of SYSTEM.OS with SYSTEM.UNPACK failed
11176 Found a pending write request for a pipe while in Close_Object when it is called by the last writer of the pipe
11177 Found a pending read request for a pipe while in Close_Object when it is called by the (only possible) reader of the pipe
11178 Found a pending read request for a pipe while in Read_Data from the pipe
11180 Found a pending write request for a pipe while in Write_Data to the pipe
118xx Error xx from diskette ROM (See OS errors 18xx)
11901 Call to Getspace or Relspace with a bad parameter, or free pool is bad

apple computer

Lisa 1.0 Technical Procedures

Section 1

Illustrated Parts List

The figures and lists below include all piece parts that can be purchased separately from Apple for the Lisa 1.0, along with their part numbers. These are the only parts available from Apple. Refer to your Apple Service Programs manual for prices.

Contents:

apple computer

070-0183-A 1/8

REV	ZONE	ECO #	REVISION	APPD
A		5493	INITIAL RELEASE	

apple computer inc.

NOTICE OF PROPRIETARY PROPERTY

METRIC

ILLUSTRATED PARTS LIST
LISA 1

SERV N/A

B 070-0183-A 1/8

NOTE: UNLESS OTHERWISE SPECIFIED
1. MANUAL REFERENCE: 072-0085

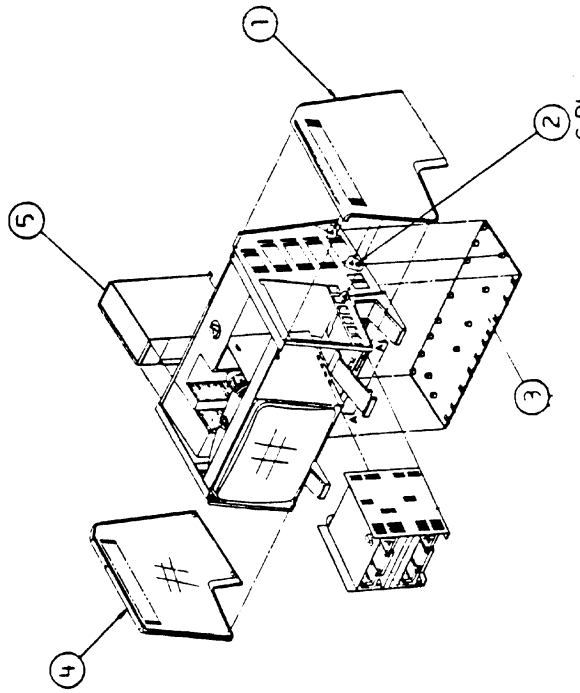


Figure 1

apple computer

LISA 1.0 CHASSIS 3 (Figure 1)

Item	Part No.	Description
1	815-4073	Right Side Plastic
2	430-3001	Bottom Pan Screw, Tap 6-20x0.375
3	815-4090	Bottom Pan
4	815-4074	Left Side Plastic
5	661-93108	Lisa 1.0/2.0 Power Supply

apple computer

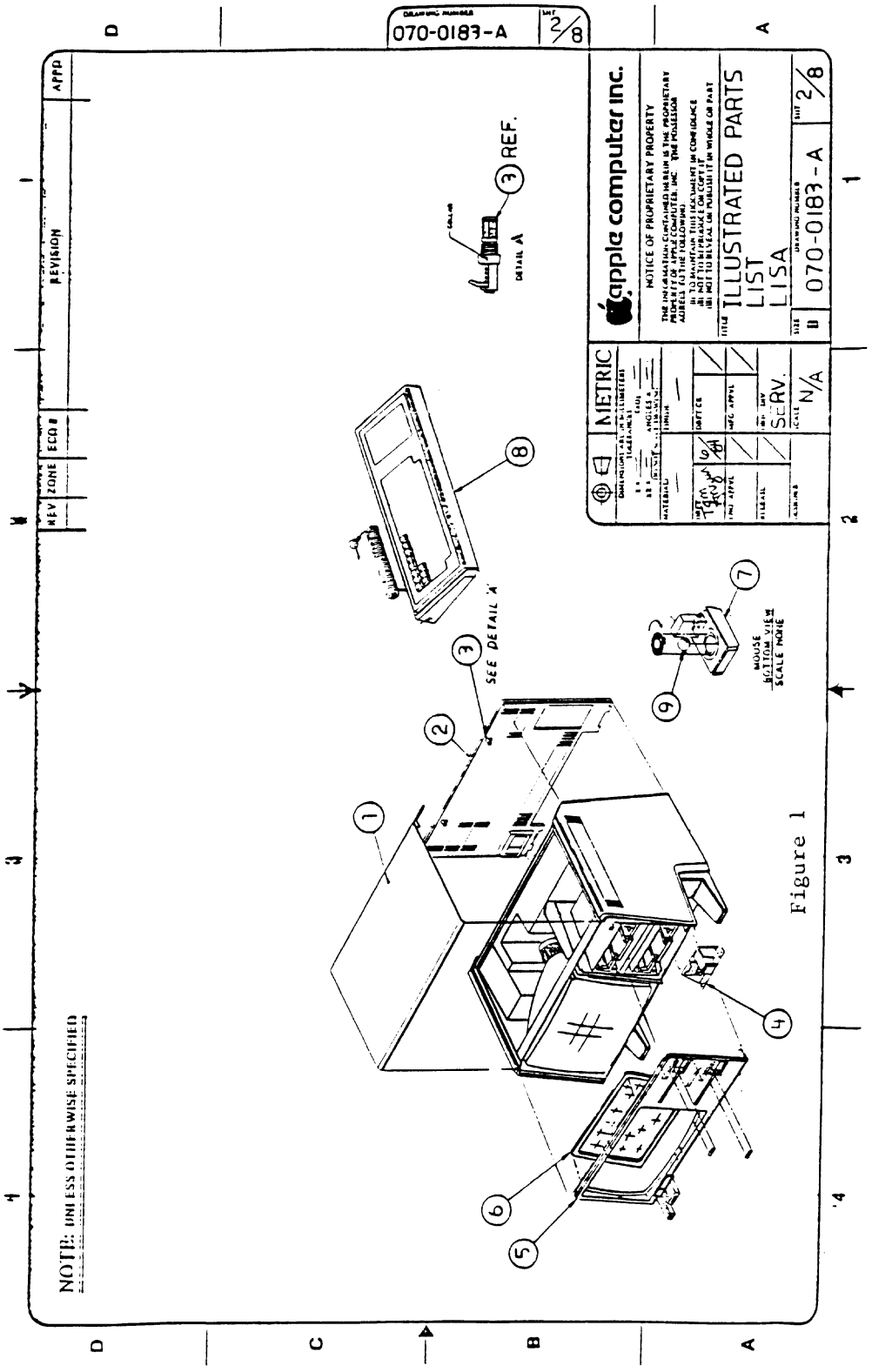


Figure 1

apple computer

LISA 1.0 TOP ASSEMBLY (Figure 2)

Item	Part No.	Description
1	815-4075	Top Cover Plastic
2	620-5105	Subassembly, Back
3	830-0051	Fastener, 1/4 Turn
4	076-0104	Lisa/Macintosh XL Soft Switch Assembly
5	620-5127	Lisa 1.0 Bezel Subassembly
6	620-6112	Glare Screen Assembly
7	661-93111	Lisa Mouse
8	661-93109	Lisa/Macintosh XL Keyboard
9	699-8001	Rubber Coated Mouse Ball

apple computer

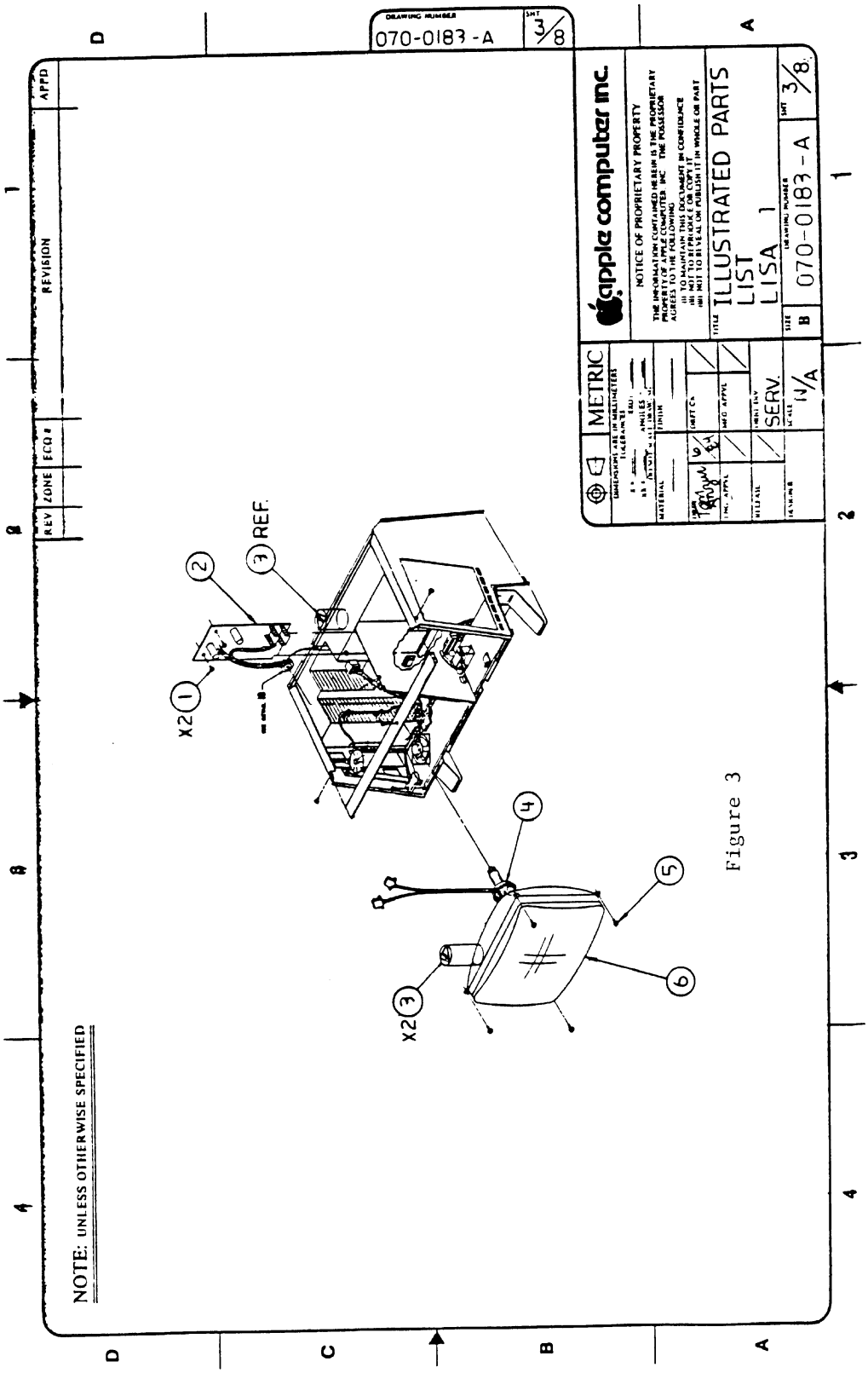


Figure 3

apple computer

LISA 1.0 VIDEO ASSEMBLY (Figure 3)

Item	Part No.	Description
1	400-1603	Video Board Screw, 6-32x3/16
2	661-93107	Lisa/Macintosh XL Video Board
3	825-4002	Label, Danger
4	159-0015	Magnet, Yoke Trim
	159-0020	Magnet, Yoke, Yellow
	159-0021	Magnet, Yoke, Red
	159-0022	Magnet, Yoke, Green
	159-0023	Magnet, Yoke, Blue
5	450-0020	Serrated Washer CRT 8-32x0.375
6	076-0105	Lisa/Macintosh XL CRT Yoke Assembly

apple computer

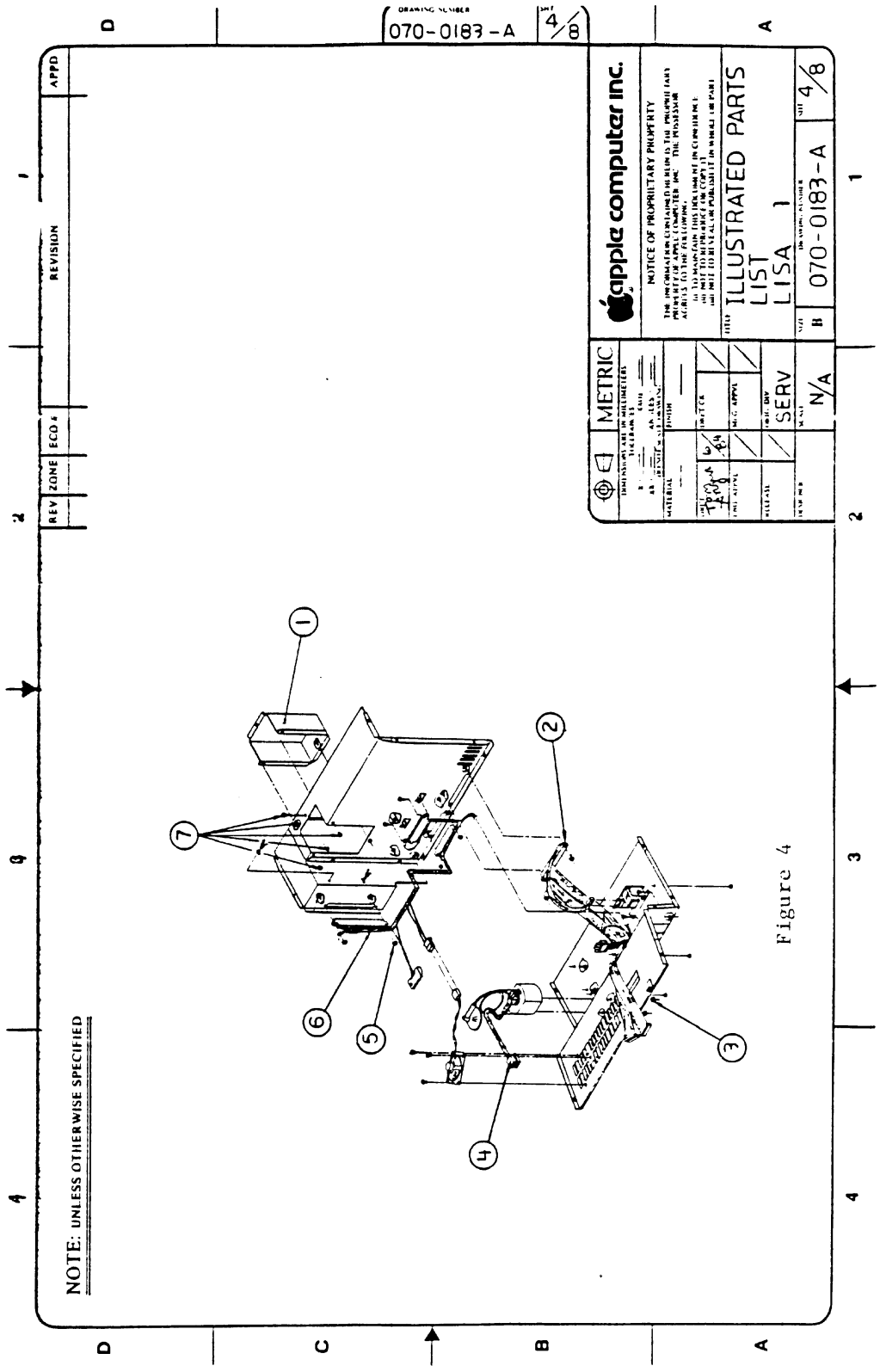


Figure 4

apple computer

LISA 1.0 CHASSIS 1 (Figure 4)

Item	Part No.	Description
1	805-4008	CRT Cup
2	591-0002	Cable Assembly, Disk Drive, Lisa 1.0/2.0
3	835-0181	Nut/Washer Assy, M3 0.5, Lisa/Macintosh XL Flyback
4	076-0106	Lisa/Macintosh XL Flyback Transformer
5	835-0150	Nut/Washer Assy, Card Cage Chamber
6	591-0003	Cable Assembly, Power, Lisa 1.0
7	400-1603	Video Board Screw, 6-32x3/16

apple computer

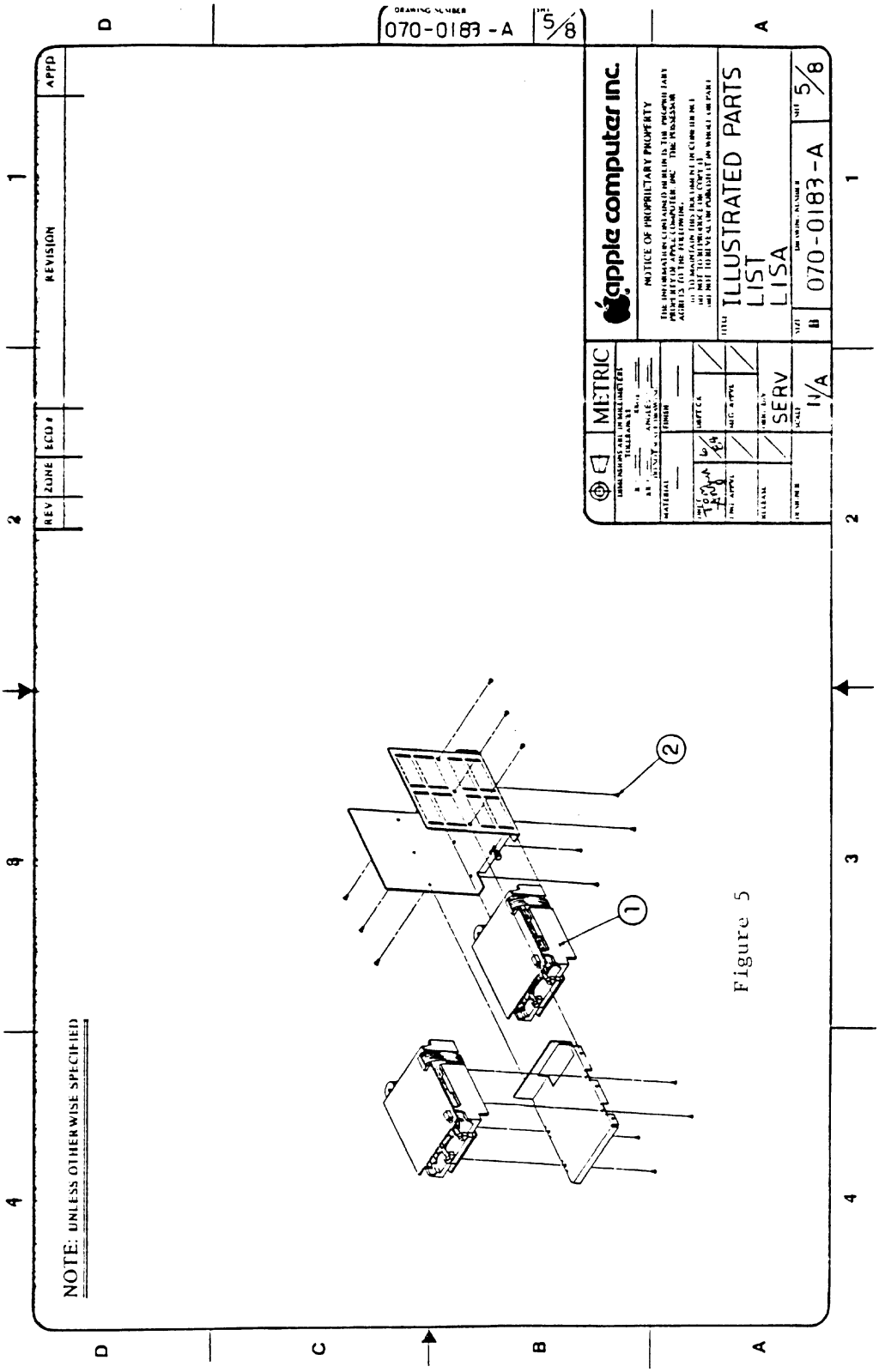


Figure 5

LISA 1.0 DISK DRIVE ASSEMBLY (Figure 5)

Item	Part No.	Description
1	661-93110	Lisa 1.0 Drive Module
2	400-3604	Disk Drive Screw, 6-32x1/4

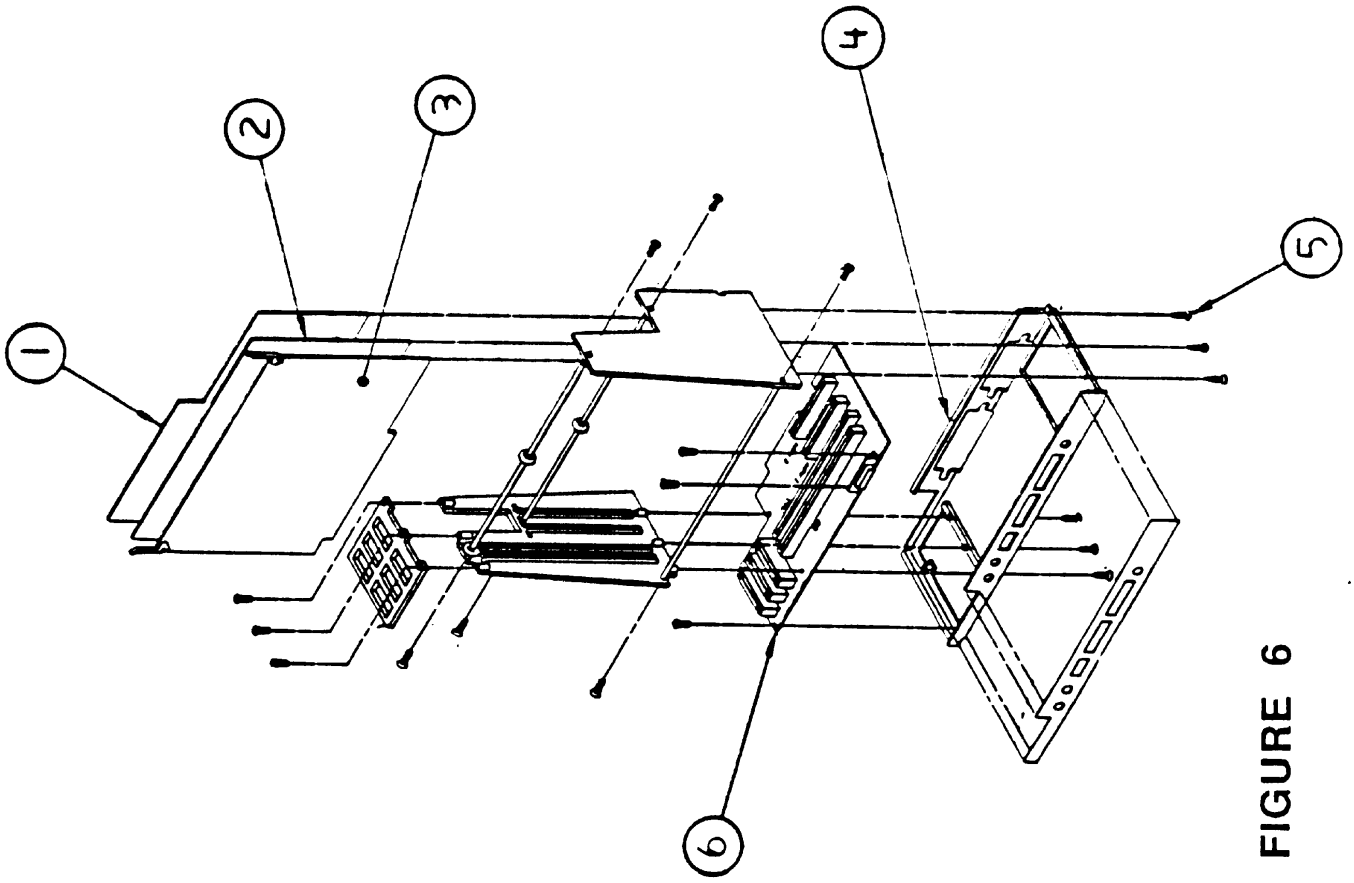


FIGURE 6

LISA 1.0 CARD CAGE (Figure 6)

Item	Part No.	Description
1	661-93105	Lisa/Macintosh XL Memory Board
2	661-93103	Lisa/Macintosh XL CPU Card
3	661-93104	Lisa 1.0 I/O Board
4	805-4046	Lisa 1.0/2.0 Card Cage Chassis
5	400-1405	Card Cage Screw, 4-40 x 5/16
6	661-93106	Lisa 1.0/2.0 Motherboard

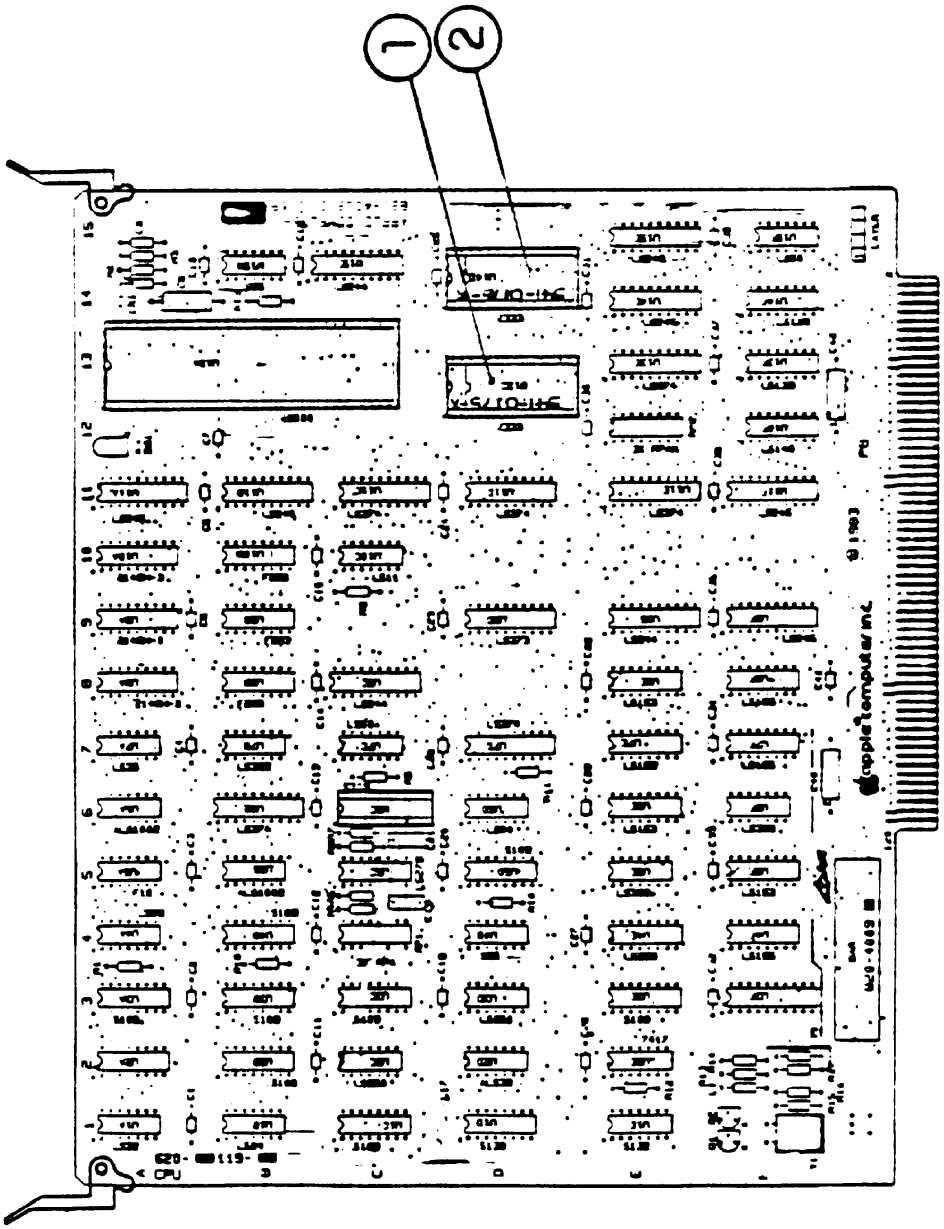


FIGURE 7

apple computer

LISA CPU BOARD (Figure 7)

Item	Part No.	Description
1	341-0175	Boot ROM, High 64K
2	341-0176	Boot ROM, Low 64K

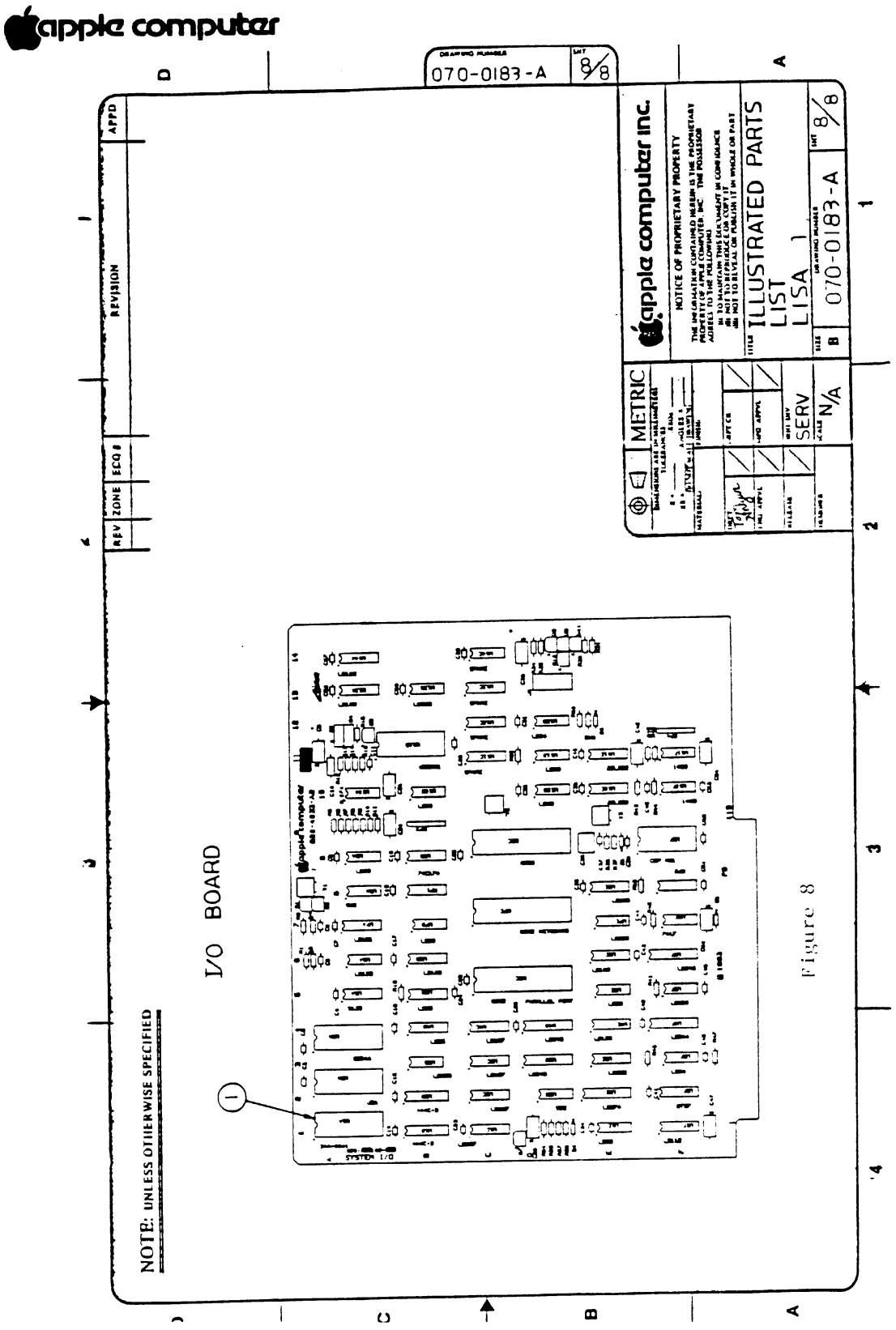

apple computer
070-0183-A
8/8
apple computer inc.
NOTICE OF PROPRIETARY PROPERTY
METRIC
SERV
N/A
ILLUSTRATED PARTS LIST
LISA 1
070-0183-A
8/8
REVISION
APPD
ECO #
ZONE
REV
I/O BOARD
NOTE: UNLESS OTHERWISE SPECIFIED

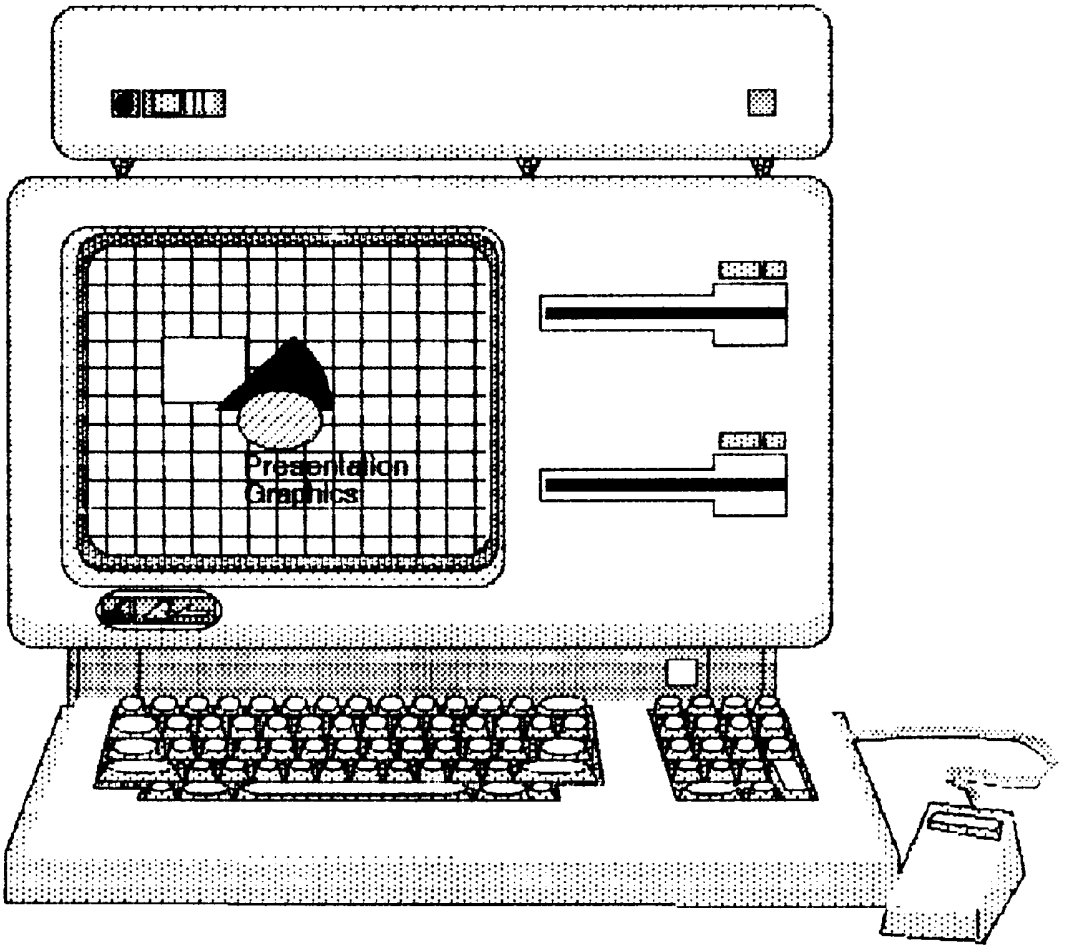
Figure 8

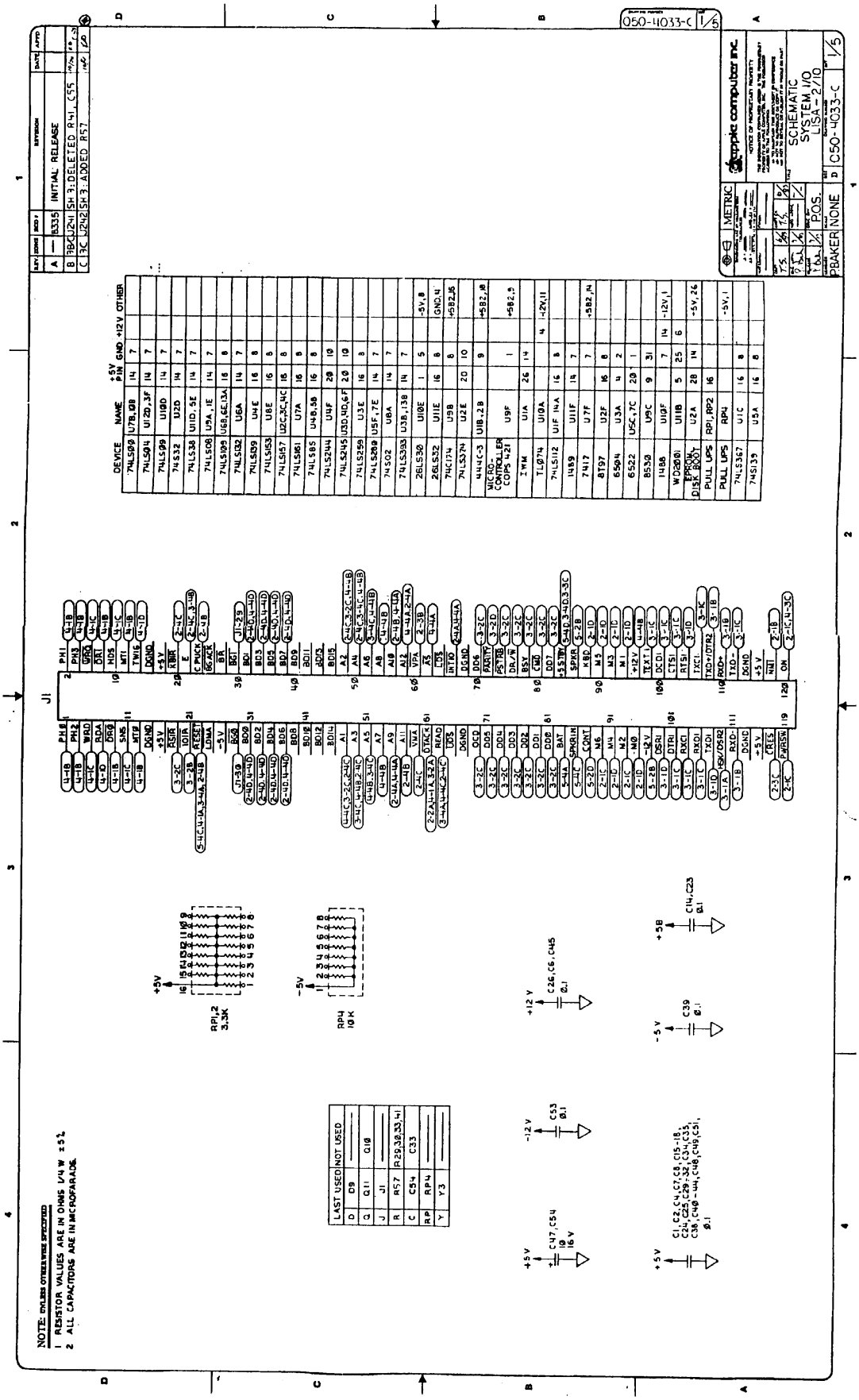
apple computer

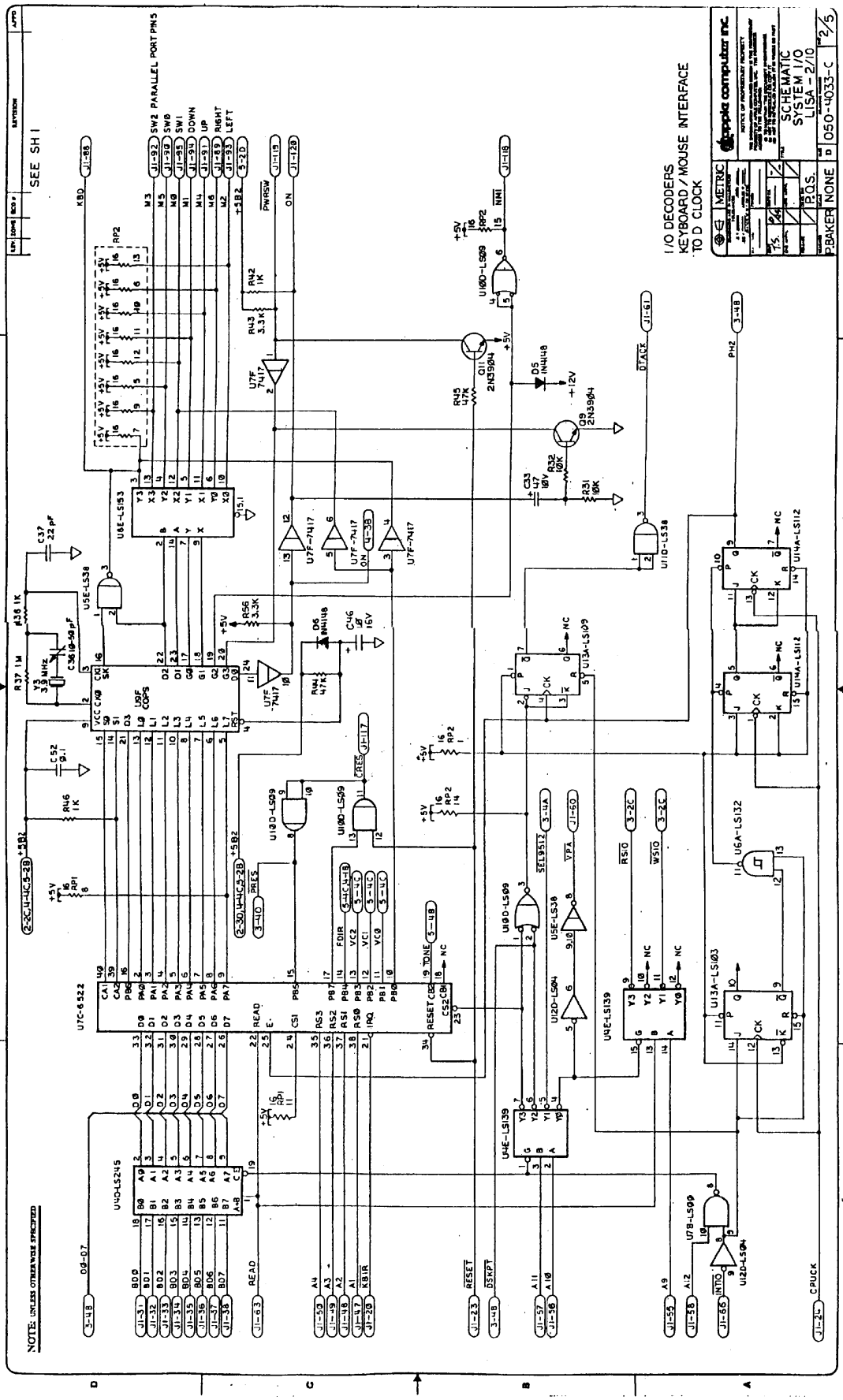
LISA I/O BOARD (Figure 8)

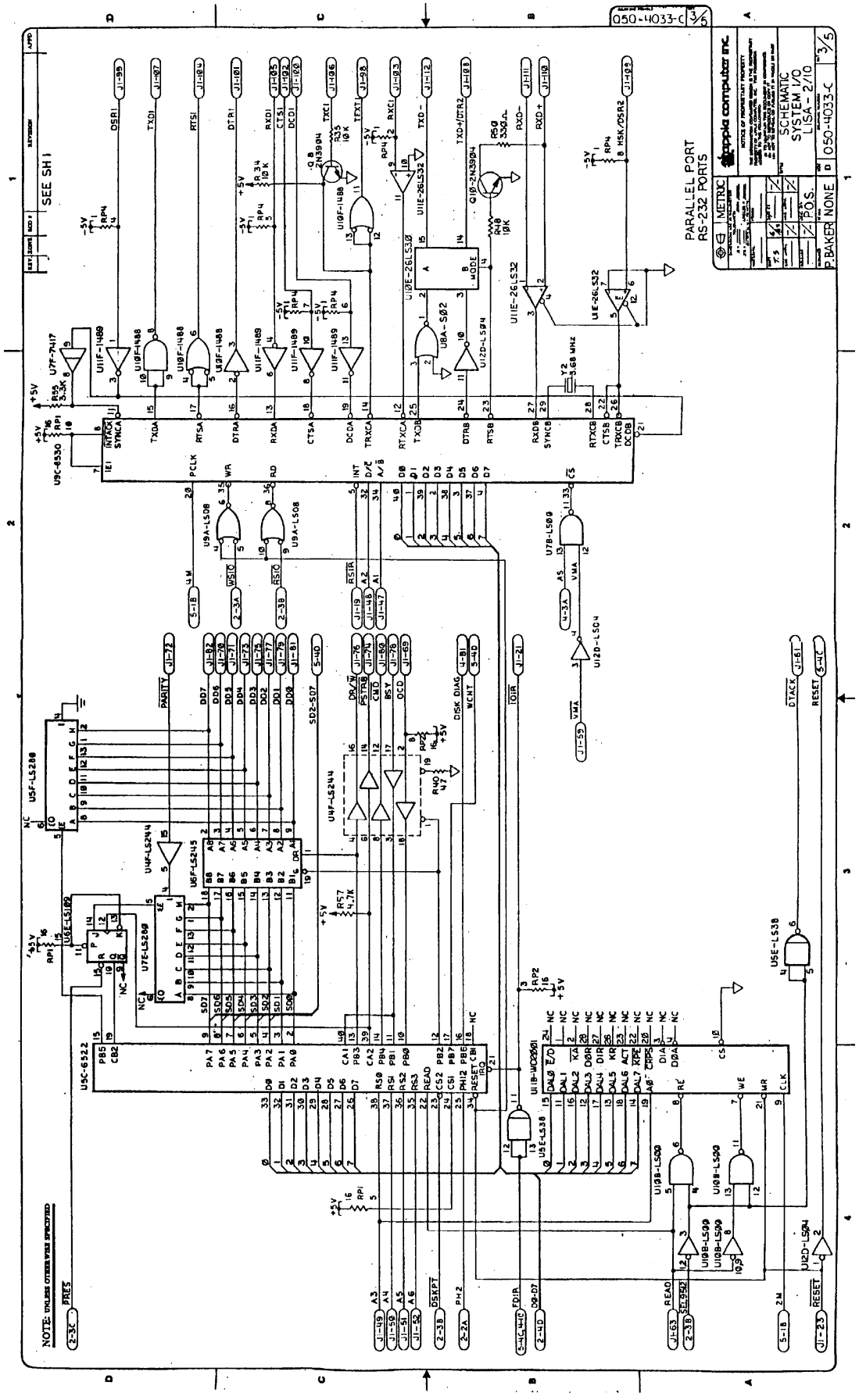
Item	Part No.	Description
1	341-0138	Disk Controller ROM

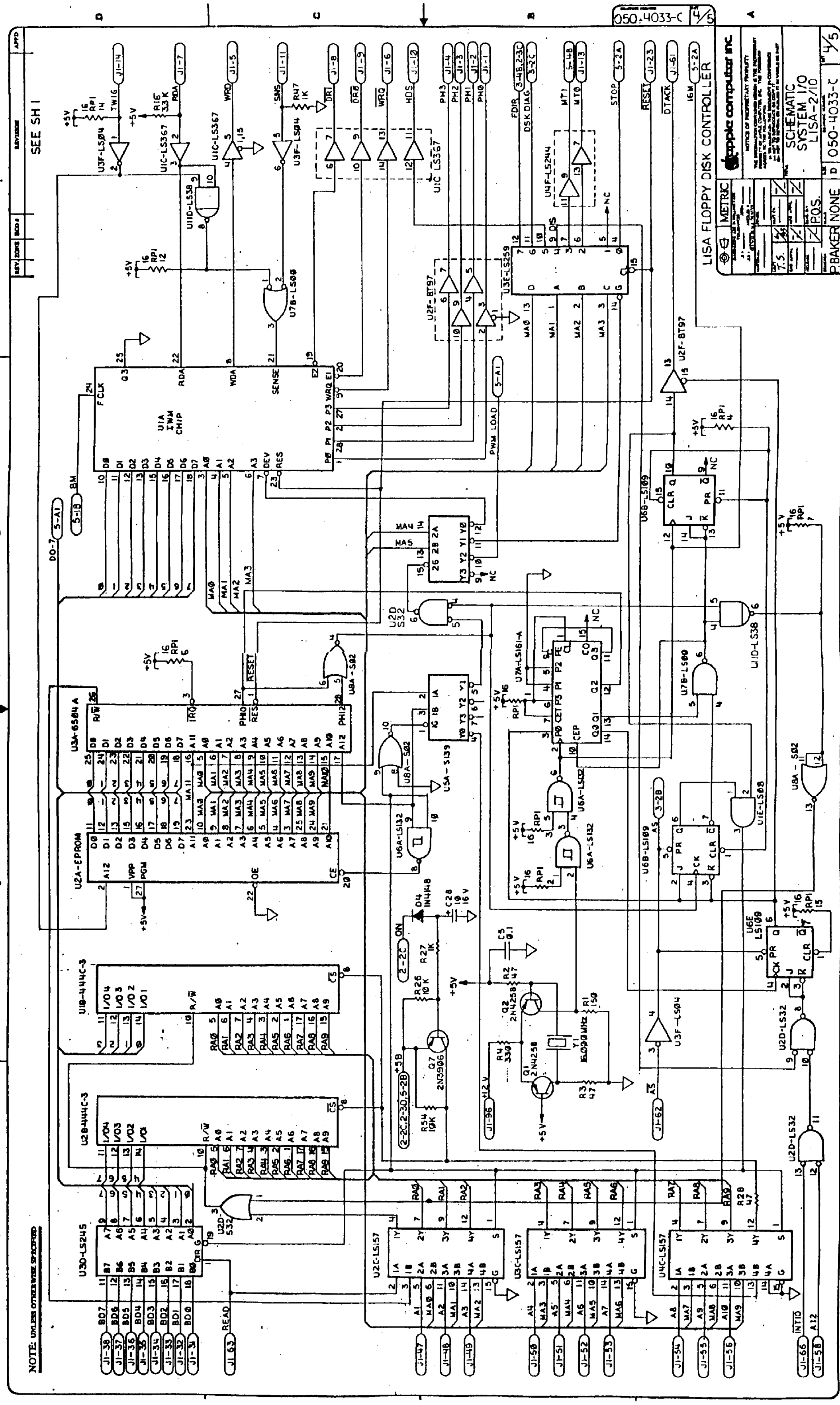
APPLE LISA COMPUTER SCHEMATICS

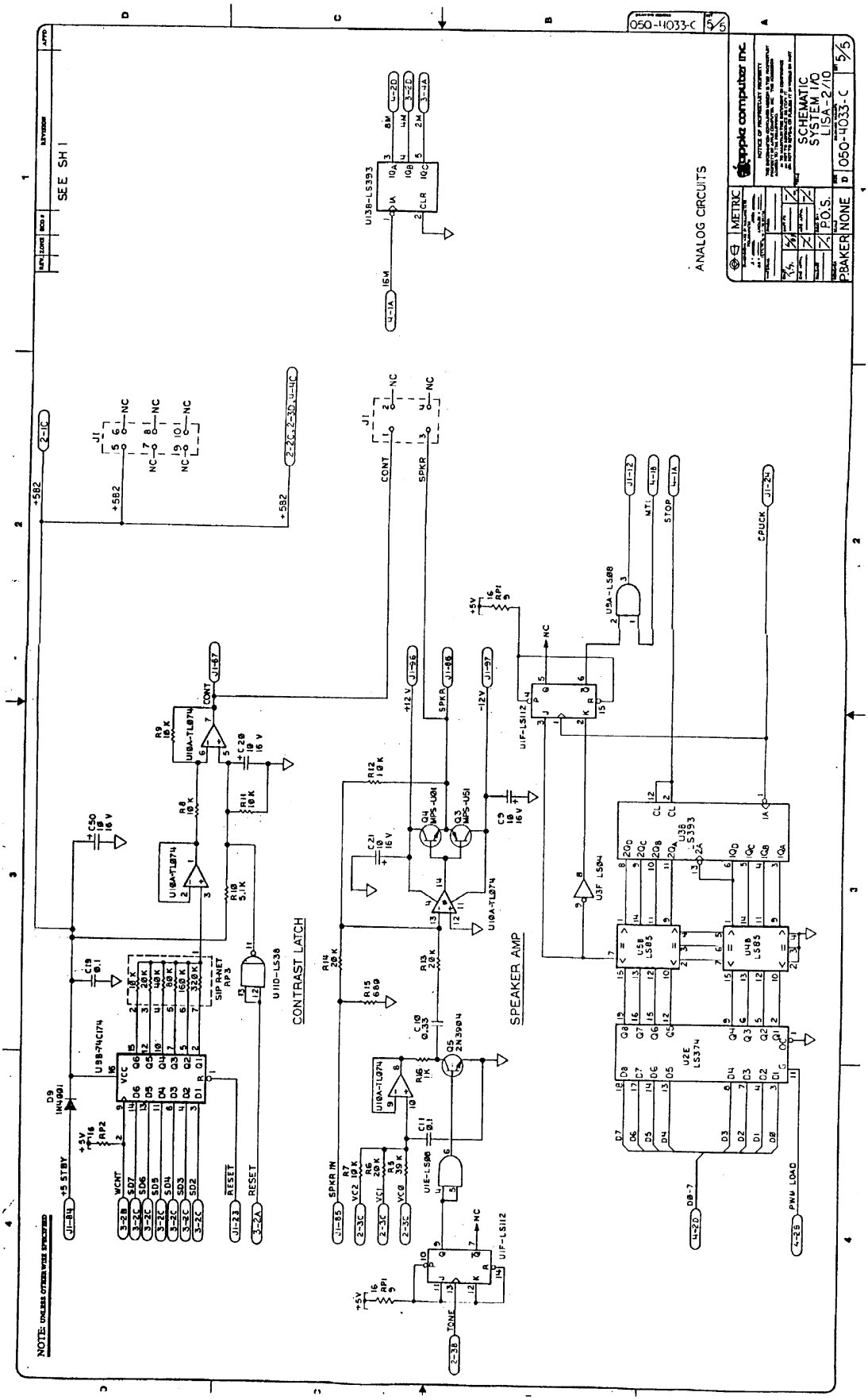


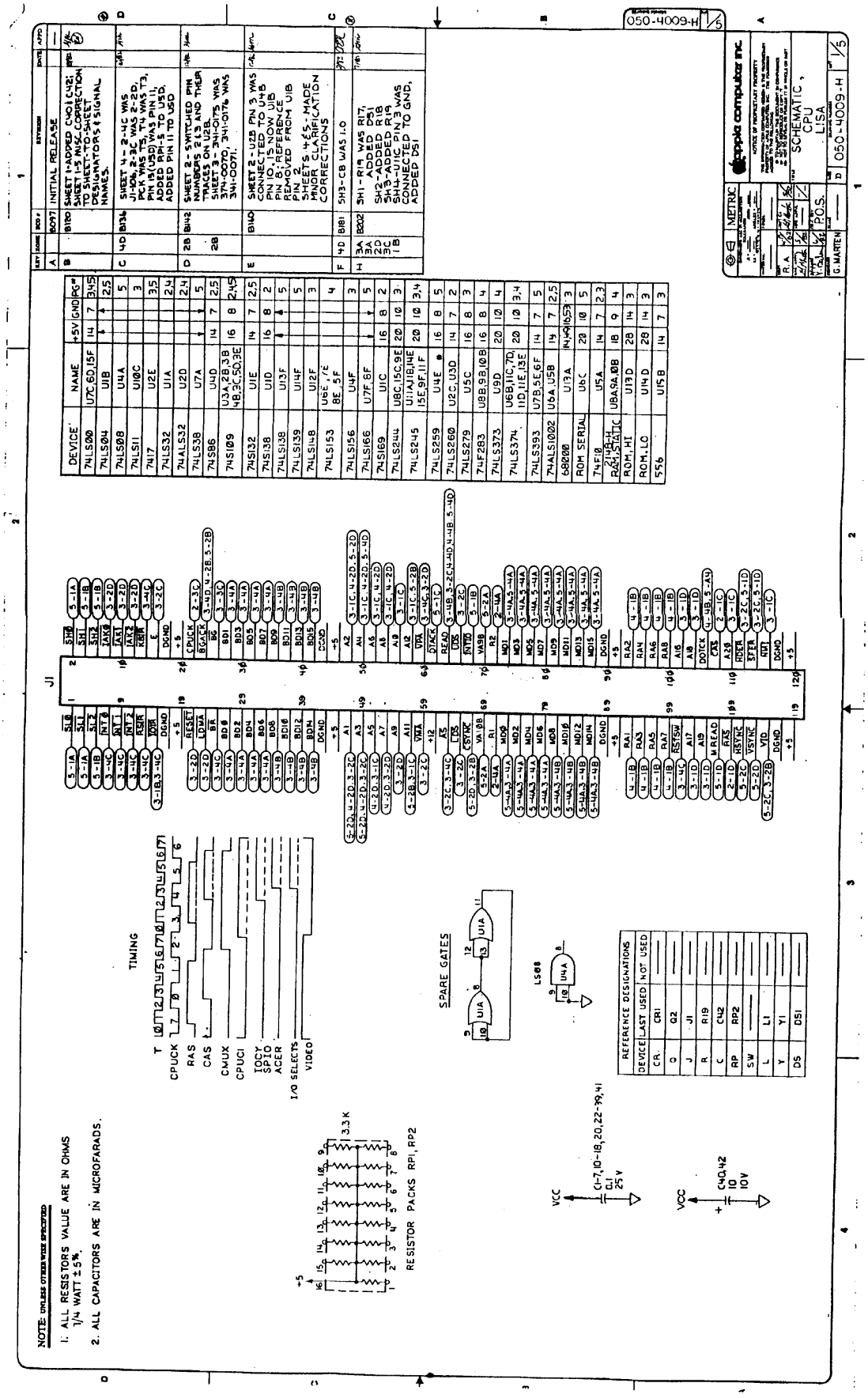

SCHEMATIC
SYSTEM I/O
LISA - 2/10
050-4033-C
1/5
apple computer inc.
NOTE: UNLESS OTHERWISE SPECIFIED
1 RESISTOR VALUES ARE IN OHMS 1/4 W ±5%
2 ALL CAPACITORS ARE IN MICROFARADS.
J1
RP1,2 3.3K
RP4 10K
+5V
-5V
+12V
-12V
C1, C2, C4, C7, C8, C15-18, C24, C25, C29-32, C34, C35, C38, C40-44, C48, C49, C51, 0.1
C39 0.1
C47, C54 10 16V
C53 0.1
C14, C23 0.1
C26, C6, C45 0.1

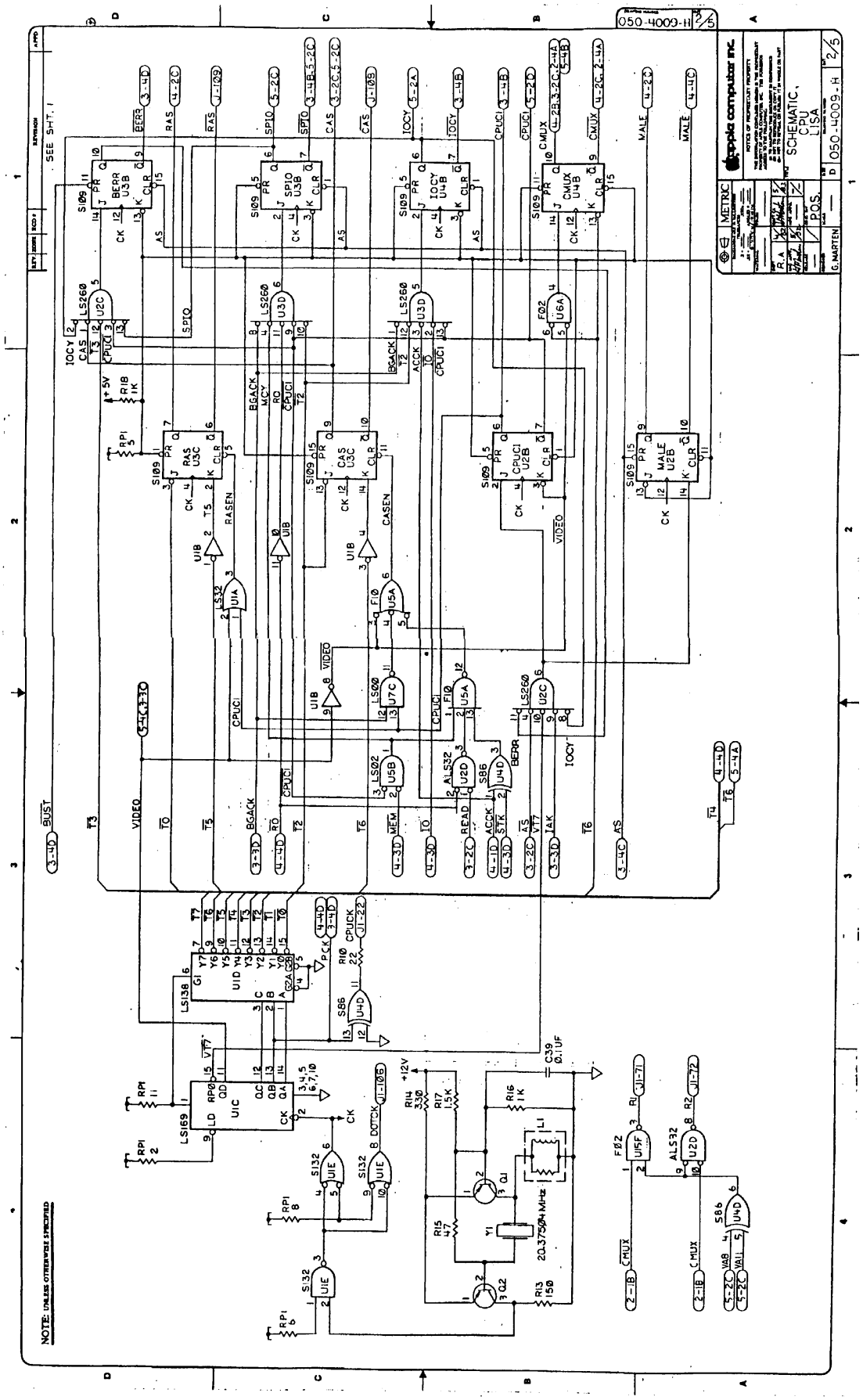

I/O DECODERS
KEYBOARD / MOUSE INTERFACE
TO D CLOCK
SCHEMATIC
SYSTEM I/O
LISA – 2/10
050-4033-C
2/5
SEE SH1
NOTE: UNLESS OTHERWISE SPECIFIED

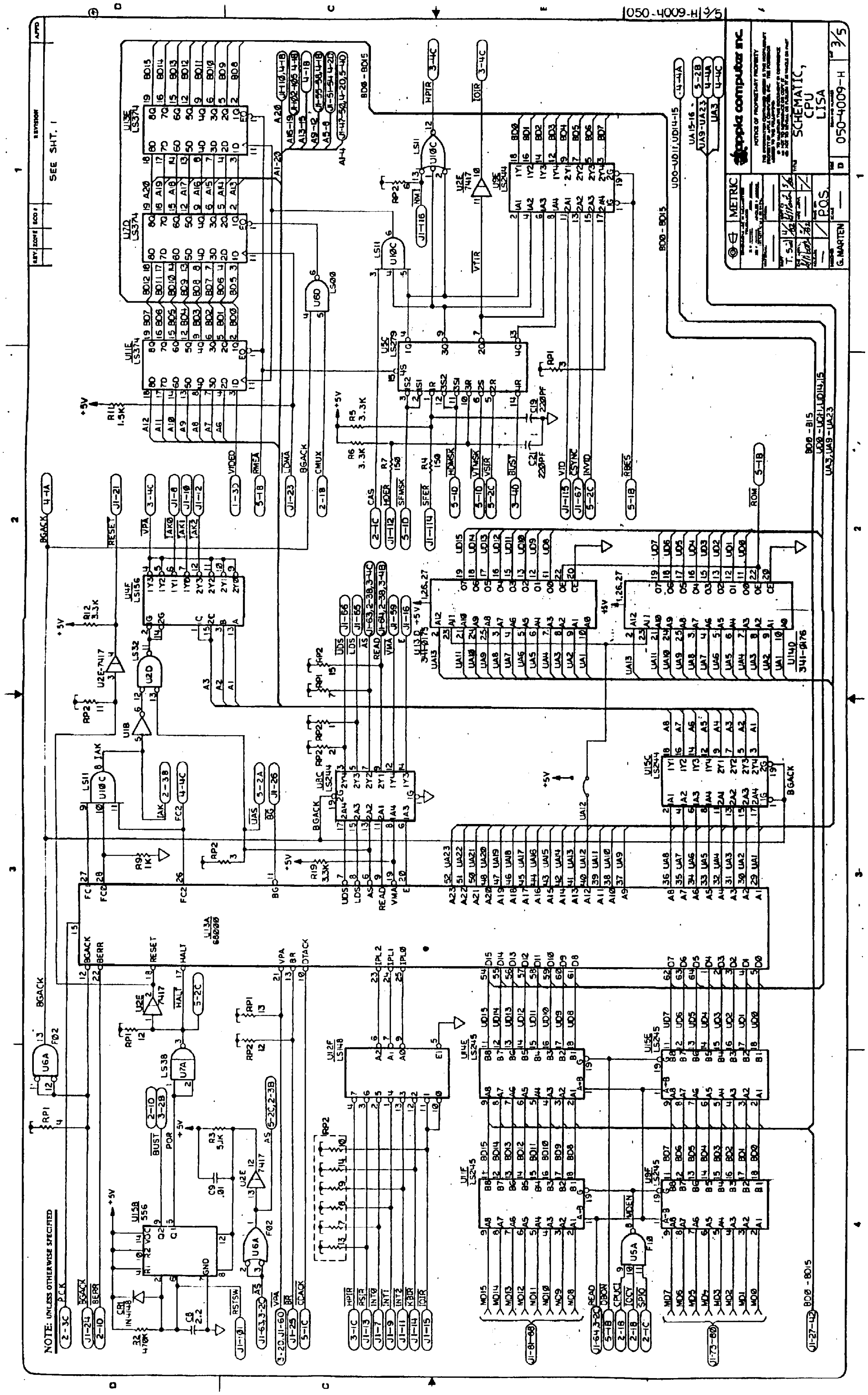

050-4033-C 3/5
SEE SH1
PARALLEL PORT
RS-232 PORTS
apple computer inc.
SCHEMATIC
SYSTEM I/O
LISA-2/10
P.BAKER NONE
050-4033-C
3/5
NOTE: UNLESS OTHER WISE SPECIFIED
PRES

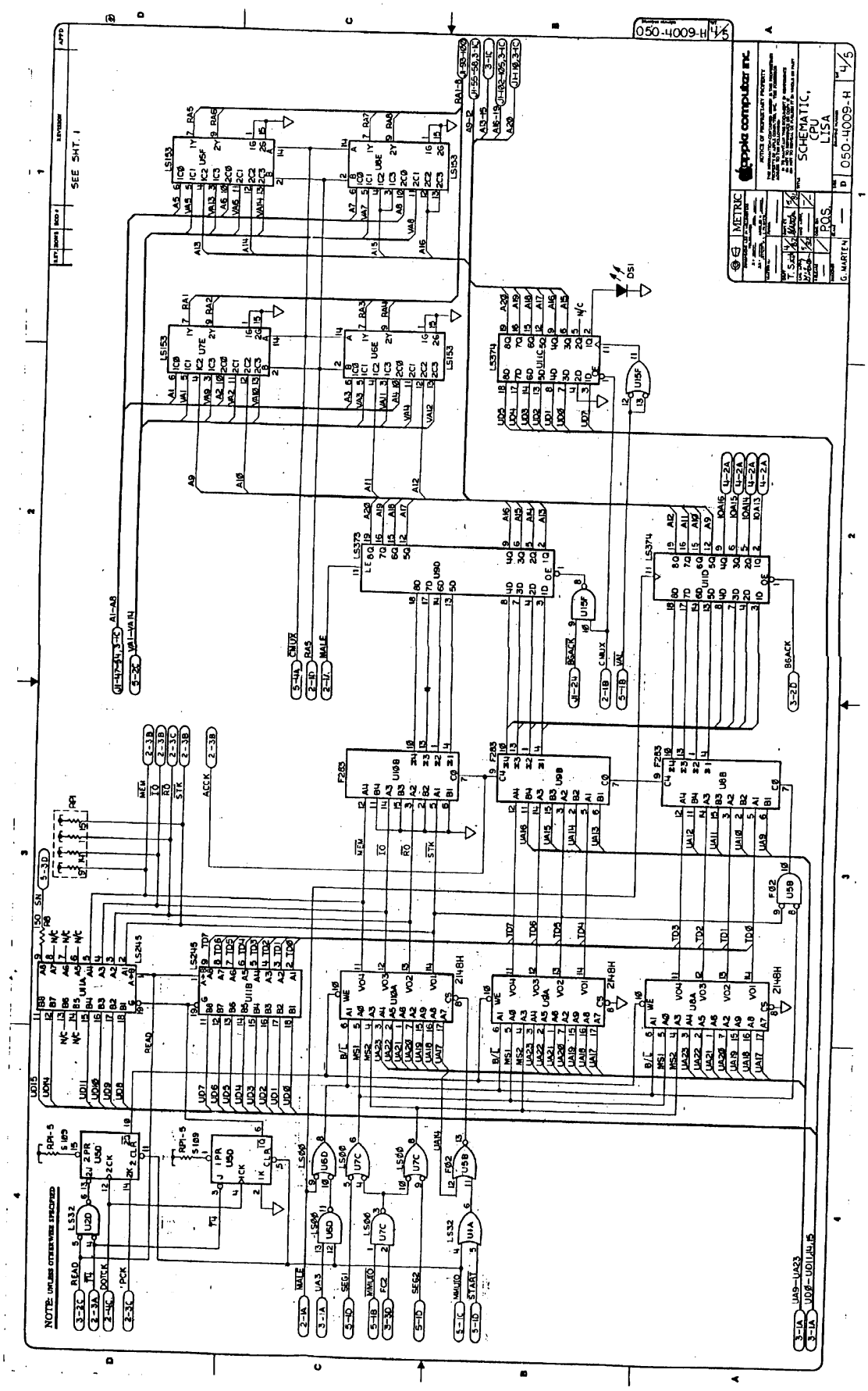

050-4033-C 4/5
SEE SH 1
LISA FLOPPY DISK CONTROLLER
SCHEMATIC
SYSTEM I/O
LISA-2/10
050-4033-C
P.BAKER
NONE
METRIC

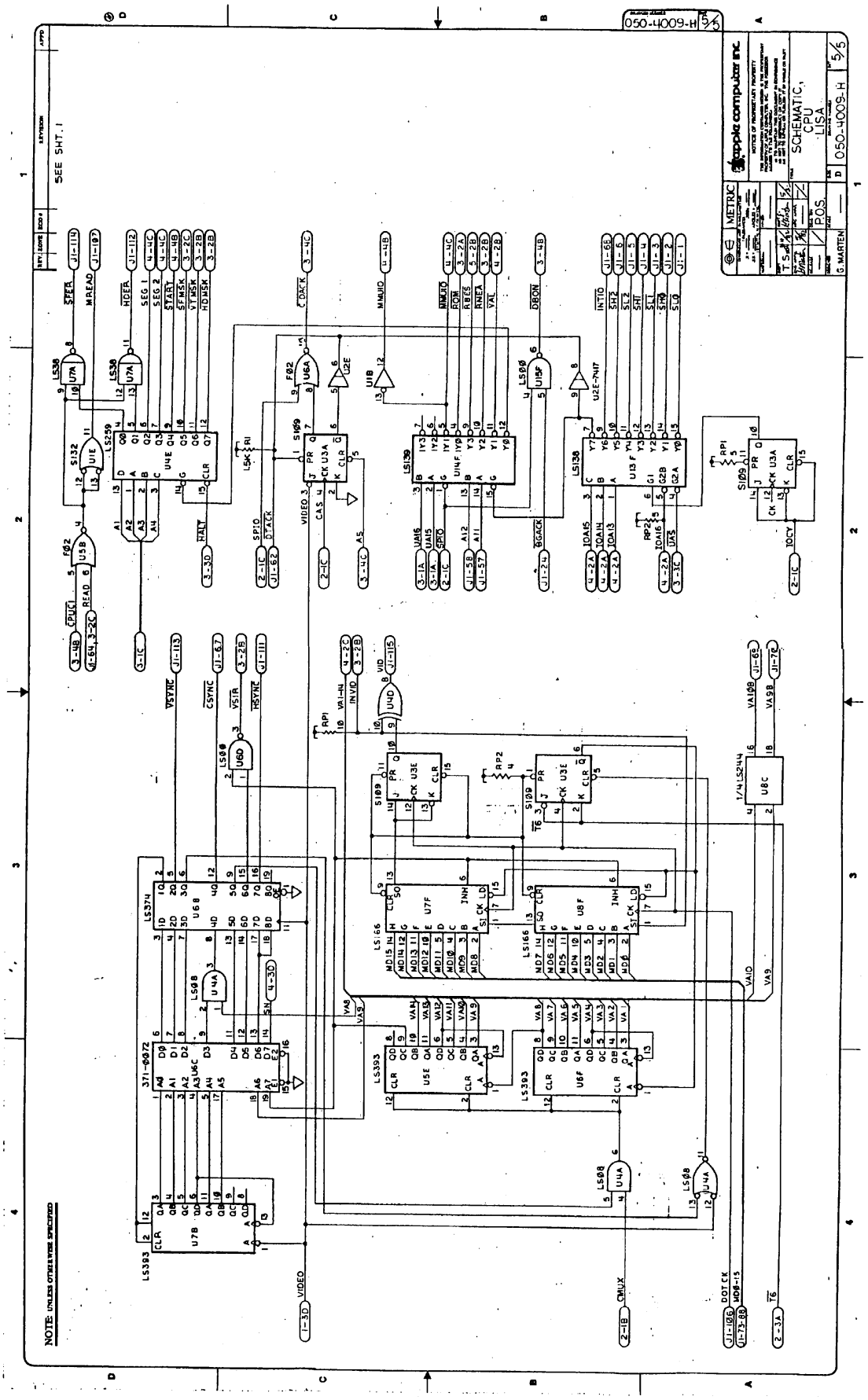

050-1033-C
5/5
apple computer inc
SCHEMATIC
SYSTEM I/O
LISA-2/10
050-1033-C
5/5
METRIC
P.O.S.
NONE
PBAKER
ANALOG CIRCUITS
SEE SH 1
CONTRAST LATCH
SPEAKER AMP
U9B-74C174
U10A-TL074
U10D-LS38
U11F-LS112
U38-LS393
U36-LS393
U4B LS85
U5B LS85
U2E LS374
U5A-LS08
U3F LS04
U13B-LS393
U11E-LS86
CONT
SPKR
RESET
WCNT
TONE
PWM LOAD
+5V STBY
+5V
+12V
-12V
+582
NC
CPUCK
NTI
STOP

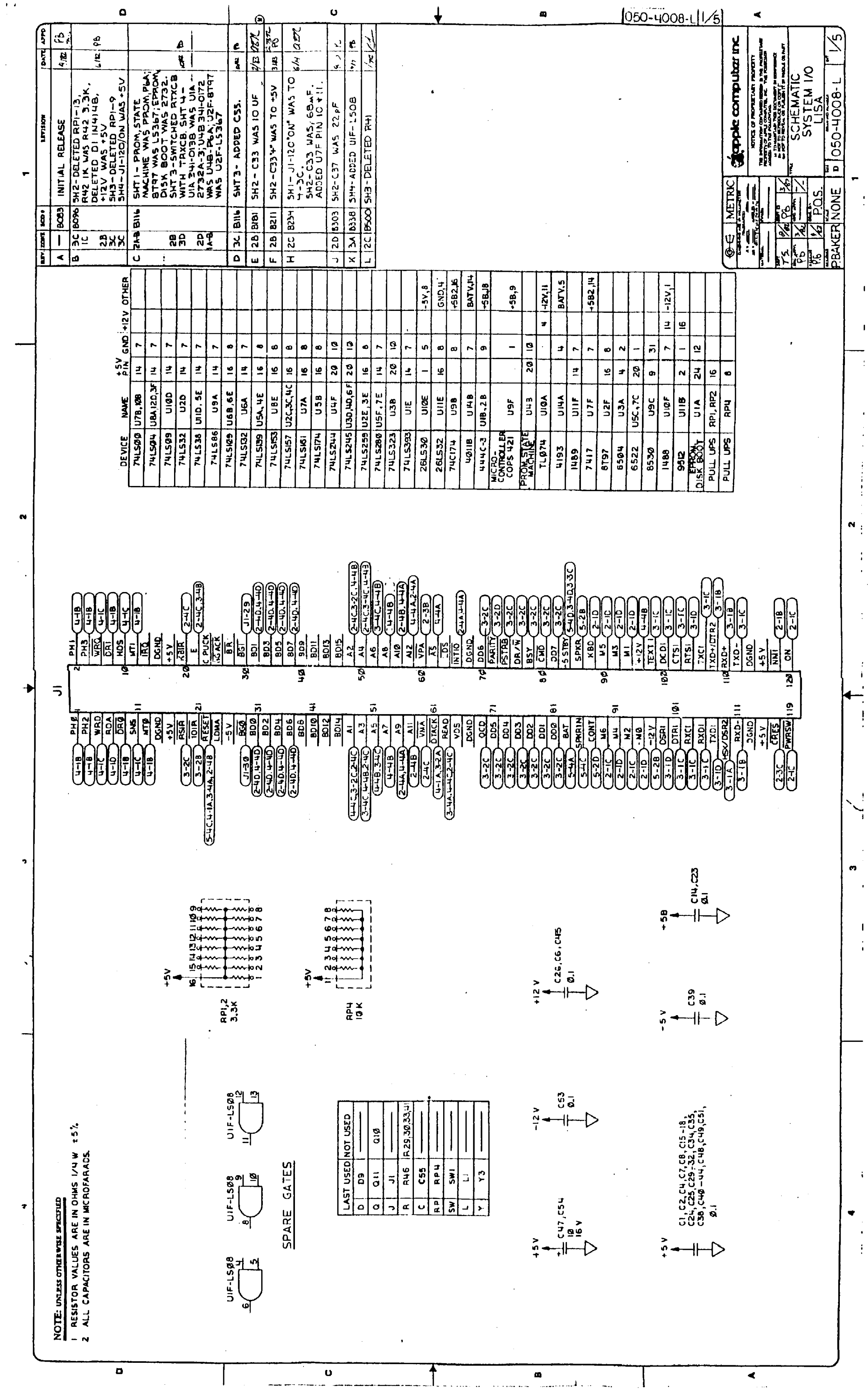

050-4009-H
SCHEMATIC, CPU LISA
apple computer inc.
NOTE: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS VALUE ARE IN OHMS 1/4 WATT ±5%.
2. ALL CAPACITORS ARE IN MICROFARADS.
TIMING
CPUCK
RAS
CAS
CMUX
CPUCI
IOCY
SPIO
ACER
I/O SELECTS
VIDEO
SPARE GATES
RESISTOR PACKS RP1, RP2
3.3 K
C1-7, 10-18, 20, 22-39, 41
25 V
C40, 42
10
10V
VCC
REFERENCE DESIGNATIONS
DEVICE | LAST USED | NOT USED
CR | CR1
Q | Q2
J | J1
R | R19
C | C42
RP | RP2
SW
L | L1
Y | Y1
DS | DS1


050-4009-H
SCHEMATIC,
CPU
LISA
050-4009-H
D
2/5
apple computer inc.
METRIC
R.A
G.MARTEN
SEE SHT. 1
NOTE: UNLESS OTHERWISE SPECIFIED


050-4009-H 3/5
SCHEMATIC, CPU LISA
050-4009-H


050-4009-H
SCHEMATIC,
CPU
LISA
050-4009-H
METRIC
POS.
NOTE: UNLESS OTHERWISE SPECIFIED
SEE SHT. 1

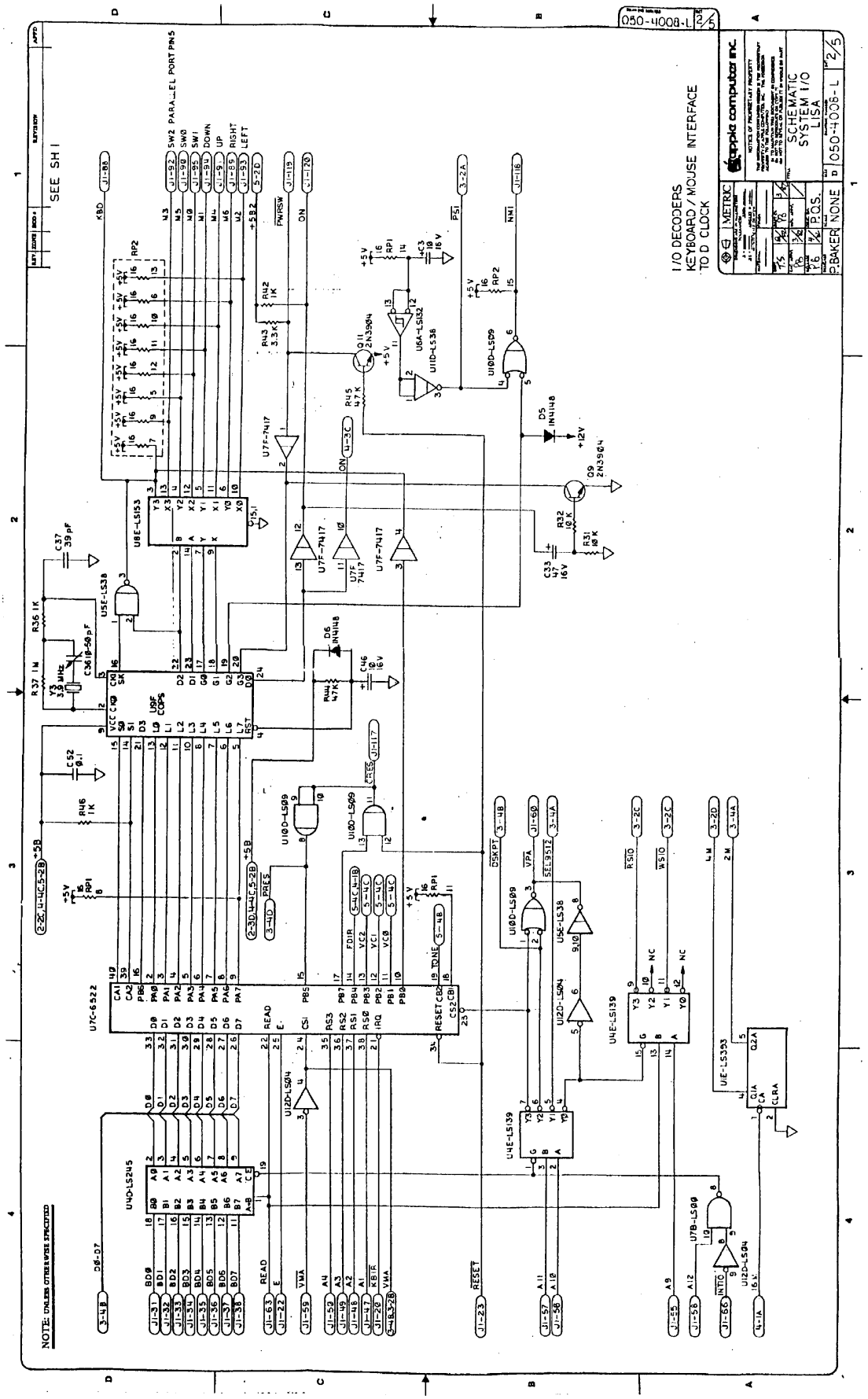

050-4009-H
SCHEMATIC,
CPU
LISA
050-4009-H
SEE SHT. 1
NOTE: UNLESS OTHERWISE SPECIFIED

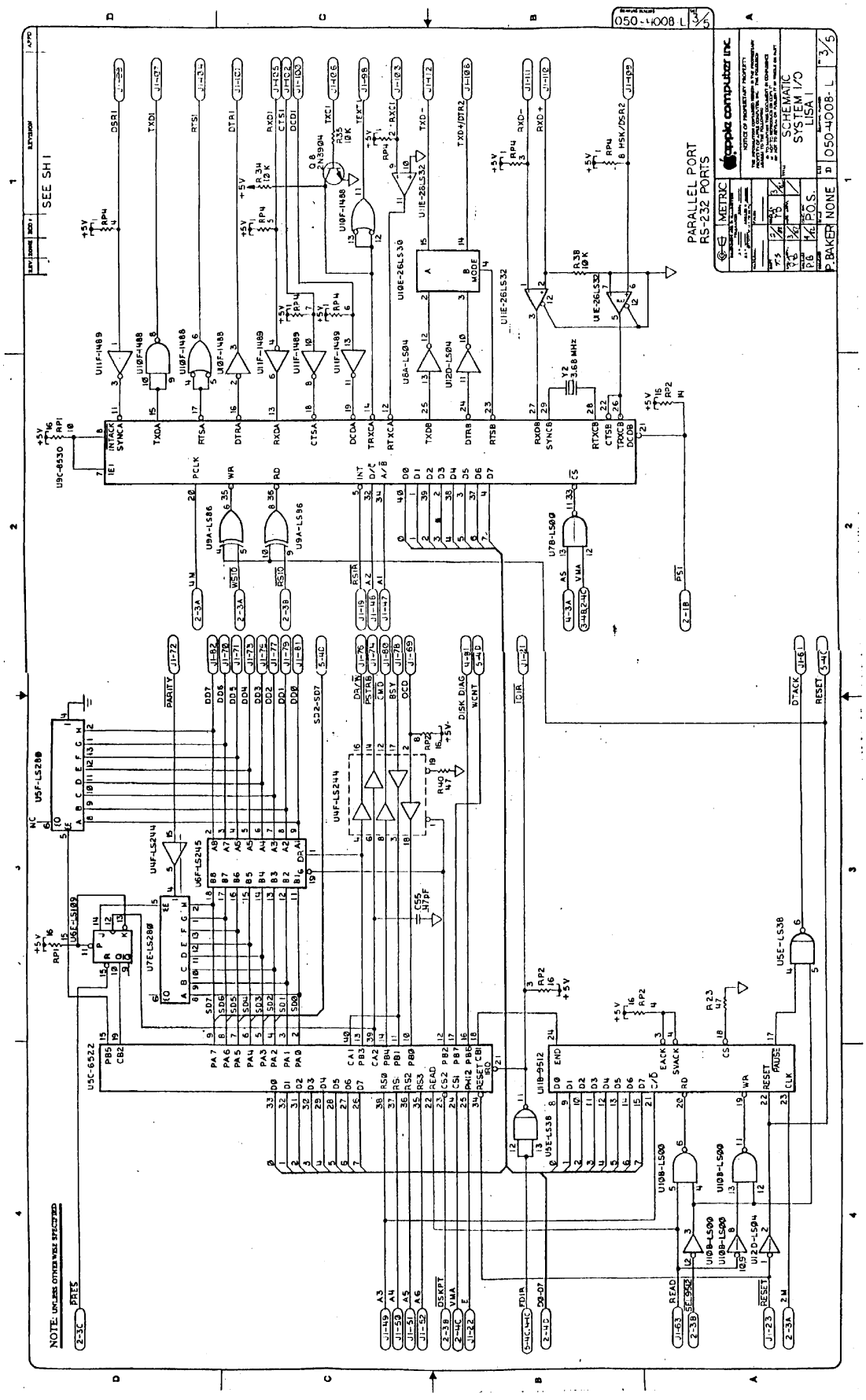


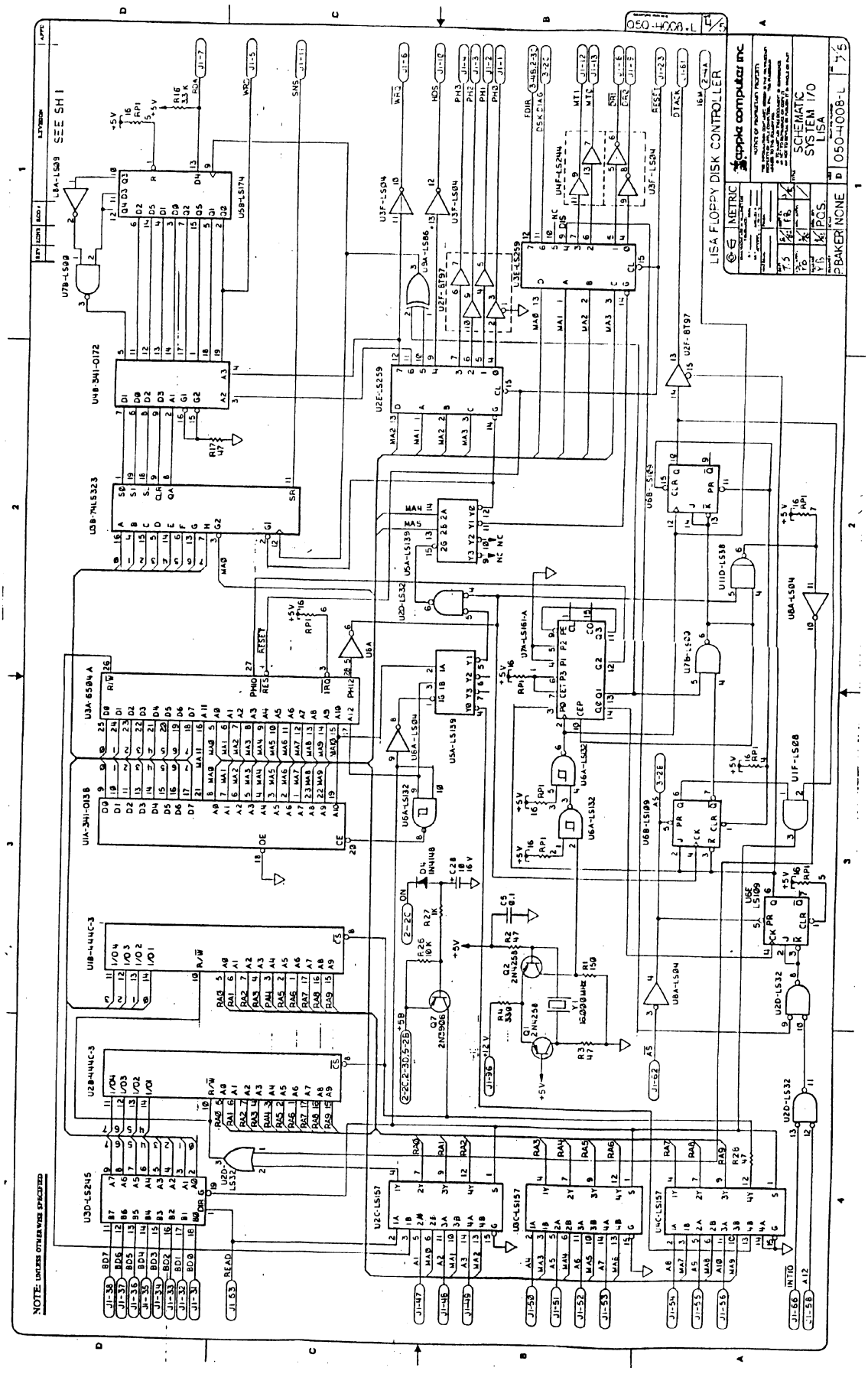
LAST USED	NOT USED
D D9	
Q Q11	Q10
J J1	
R R46	R29,30,33,41
C C55	
RP RP4	
SW SW1	
L L1	
Y Y3	

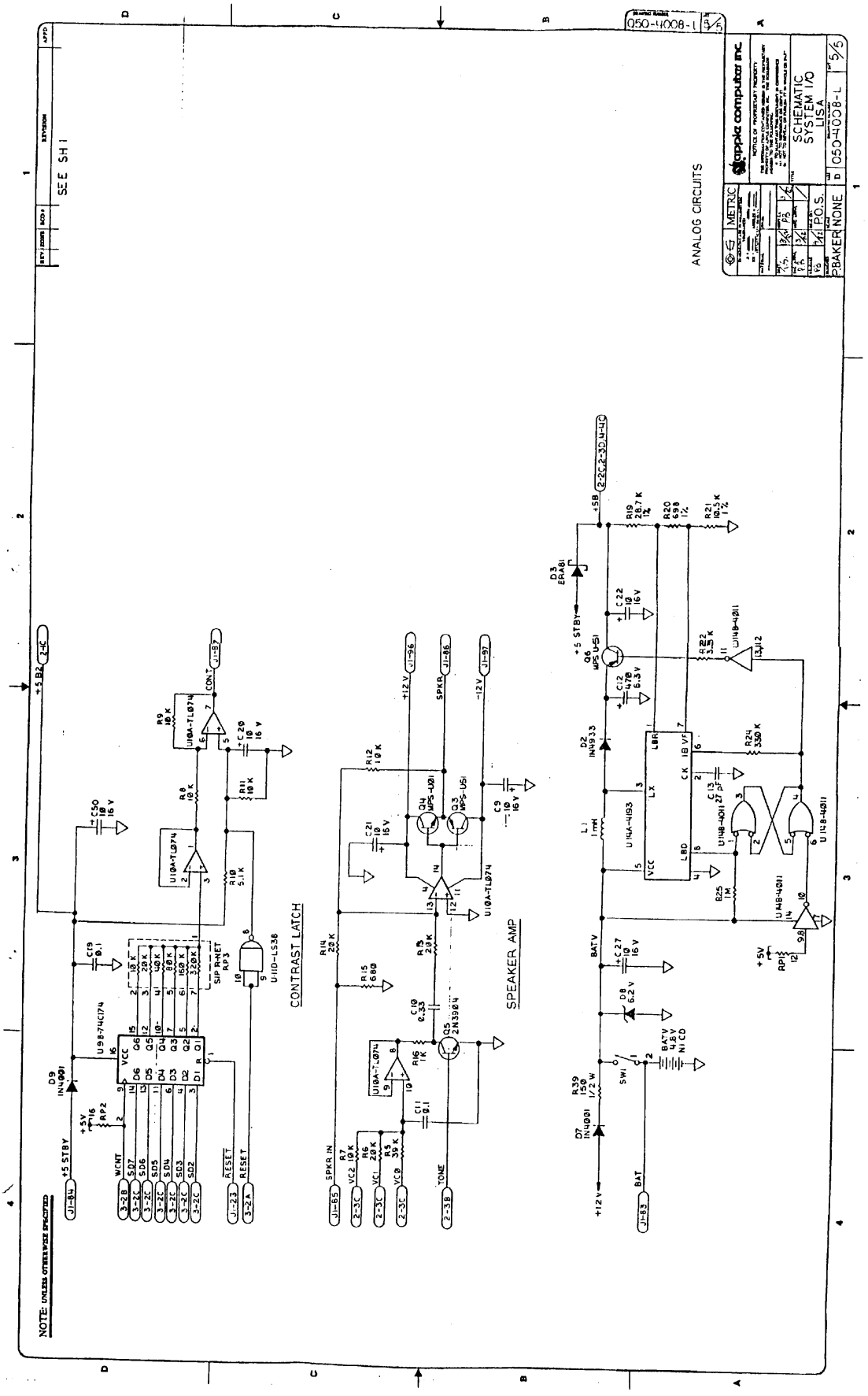
REV.	ZONE	SCO #	REVISION	DATE	APPD
A	—	8083	INITIAL RELEASE	4/82	PB
B	3C 1C 2B 3C 3C	B096	SH2-DELETED RP1-13, R42 1K WAS R42 3.3K, DELETED D1 IN4148, +12V WAS +5V SH3-DELETED RP1-9 SH4-J1-120/ON WAS +5V	6/82	PB
C	2A-B 2B 3D 2D 1A-B	B116	SHT 1- PROM, STATE MACHINE WAS PROM, P6A; 8T97 WAS LS367; EPROM DISK BOOT WAS 2732. SHT 3-SWITCHED RTXCB WITH TRXCB. SHT 4- U1A 341-0138 WAS U1A - 2732A-3; U4B 341-0172 WAS U4B-P6A; U2F-8T97 WAS U2F-LS367		
D	3C	B116	SHT 3- ADDED C55.		
E	2B	B181	SH2- C33 WAS 10 UF	2/83	
F	2B	B211	SH2-C33"+" WAS TO +5V	3/83	PB
H	2C	B234	SH1- J1-120"ON" WAS TO 4-3C. SH2- C33 WAS 68uF. ADDED U7F PIN 10 + 11.	6/4	
J	2D	B303	SH2-C37 WAS 22pF		
K	3A	B338	SH4-ADDED U1F-LS08		PB
L	2C	B500	SH3-DELETED R41		

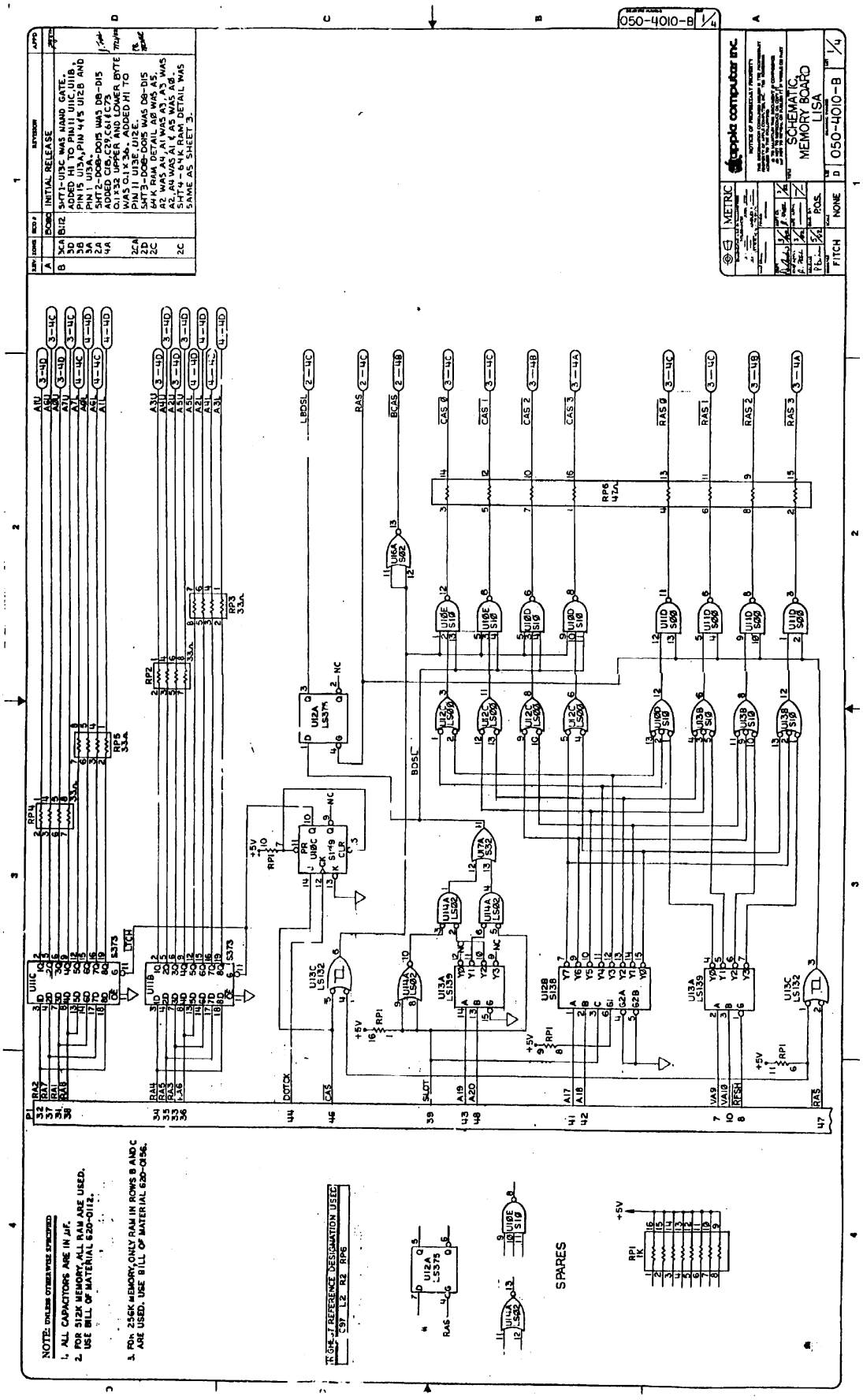
DEVICE	NAME	+5V PIN	GND	+12V	OTHER
74LS00	U7B,10B	14	7		
74LS04	U8A,12D,3F	14	7		
74LS09	U10D	14	7		
74LS32	U2D	14	7		
74LS38	U11D, 5E	14	7		
74LS86	U9A	14	7		
74LS109	U6B,6E	16	8		
74LS132	U6A	14	7		
74LS139	U5A, 4E	16	8		
74LS153	U8E	16	8		
74LS157	U2C,3C,4C	16	8		
74LS161	U7A	16	8		
74LS174	U5B	16	8		
74LS244	U4F	20	10		
74LS245	U3D,4D,6F	20	10		
74LS259	U2E, 3E	16	8		
74LS280	U5F, 7E	14	7		
74LS323	U3B	20	10		
74LS393	U1E	14	7		
26LS30	U10E	1	5		-5V,8
26LS32	U11E	16	8		GND,4
74C174	U9B		8		+5B2,16
4011B	U14B		7		BATV,14
444C-3	U1B, 2B		9		+5B,18
MICRO-CONTROLLER COPS 421	U9F		1		+5B,9
PROM STATE MACHINE	U4B	20	10		
TL074	U10A			4	-12V,11
4193	U14A		4		BATV,5
1489	U11F	14	7		
7417	U7F		7		+5B2,14
8T97	U2F	16	8		
6504	U3A	4	2		
6522	U5C, 7C	20	1		
8530	U9C	9	31		
1488	U10F		7	14	-12V,1
9512	U11B	2	1	16	
EPROM DISK BOOT	U1A	24	12		
PULL UPS	RP1, RP2	16			
PULL UPS	RP4	8			

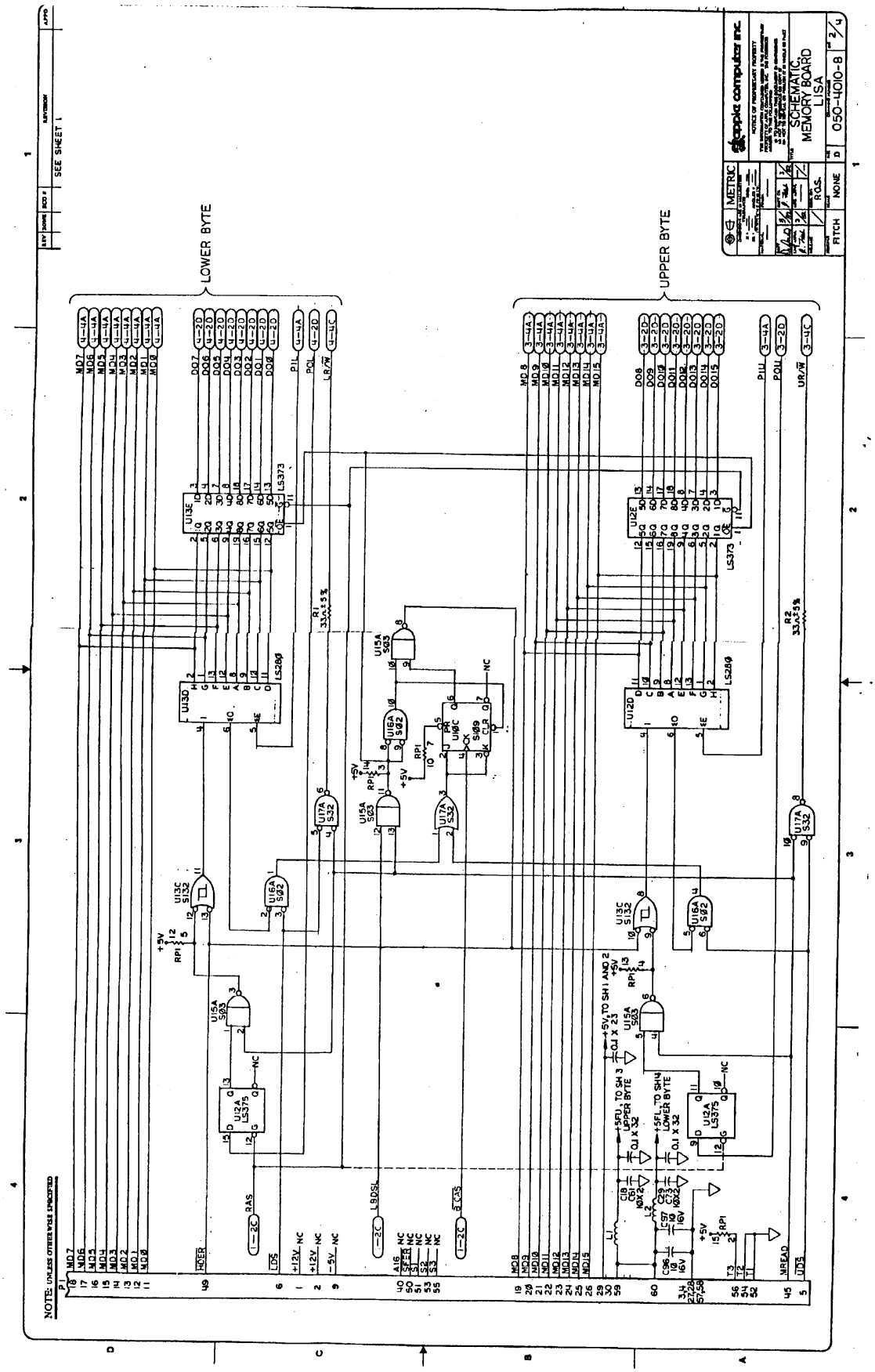

I/O DECODERS
KEYBOARD / MOUSE INTERFACE
TO D CLOCK
SCHEMATIC
SYSTEM I/O
LISA
P.BAKER
NONE
050-4008-L
SEE SH I
NOTE: UNLESS OTHERWISE SPECIFIED

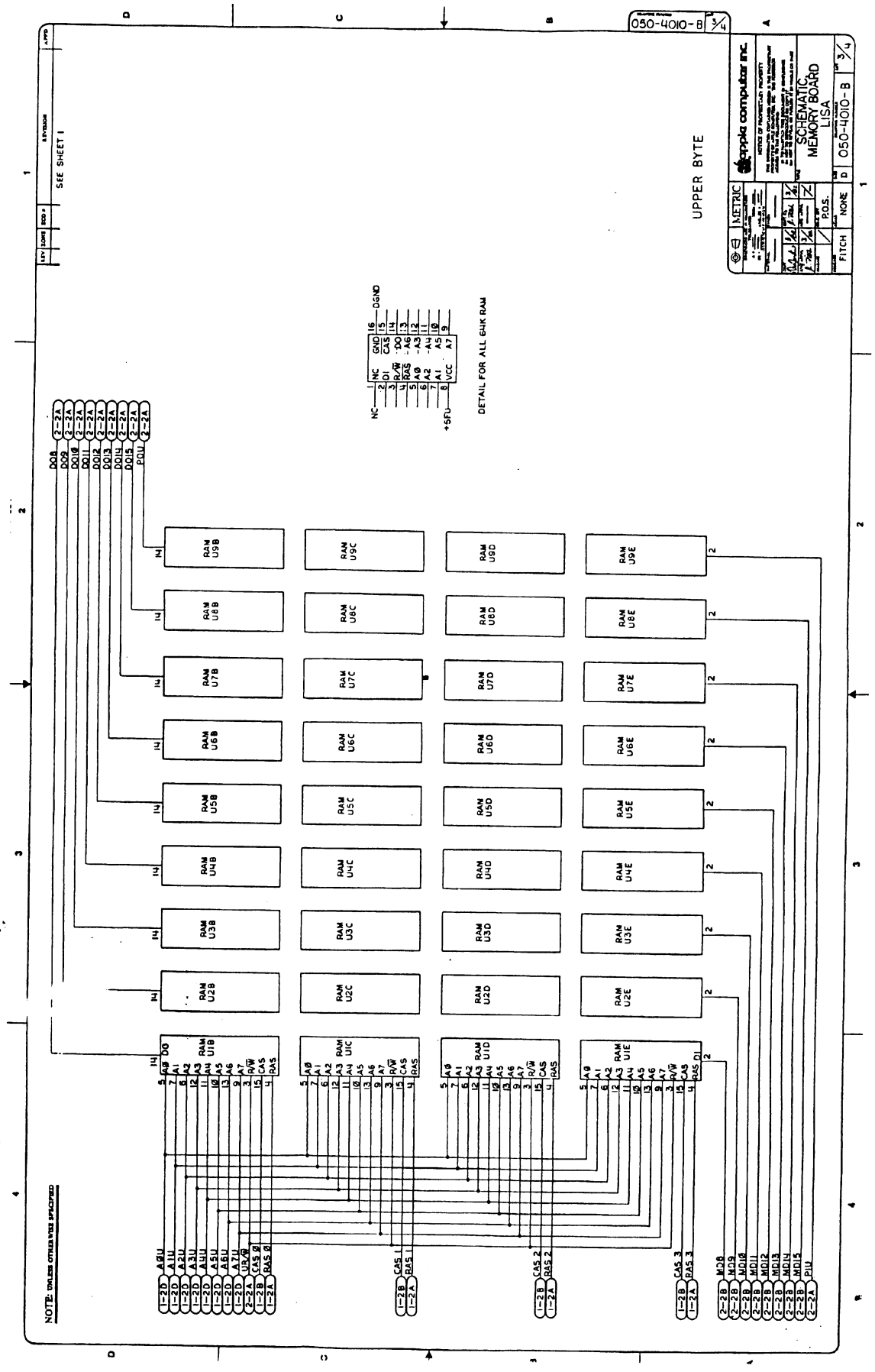

050-4008 L
SCHEMATIC
SYSTEM I/O
LISA I
050-4008- L
P.BAKER NONE
PARALLEL PORT
RS-232 PORTS
SEE SH I
NOTE: UNLESS OTHERWISE SPECIFIED

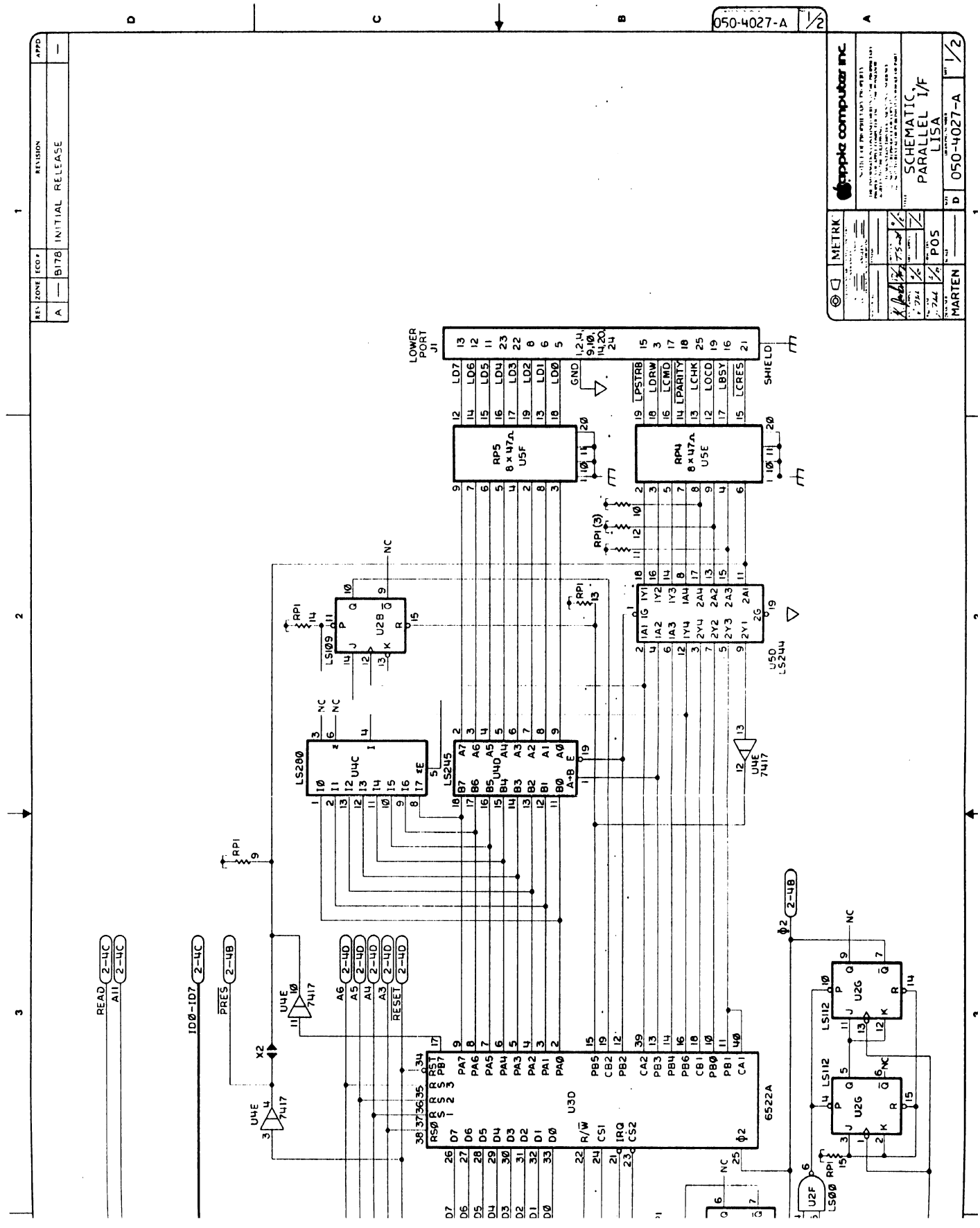

LISA FLOPPY DISK CONTROLLER
apple computer inc
SCHEMATIC
SYSTEM I/O
LISA
050-4008-L
PBAKER NONE
NOTE: UNLESS OTHERWISE SPECIFIED

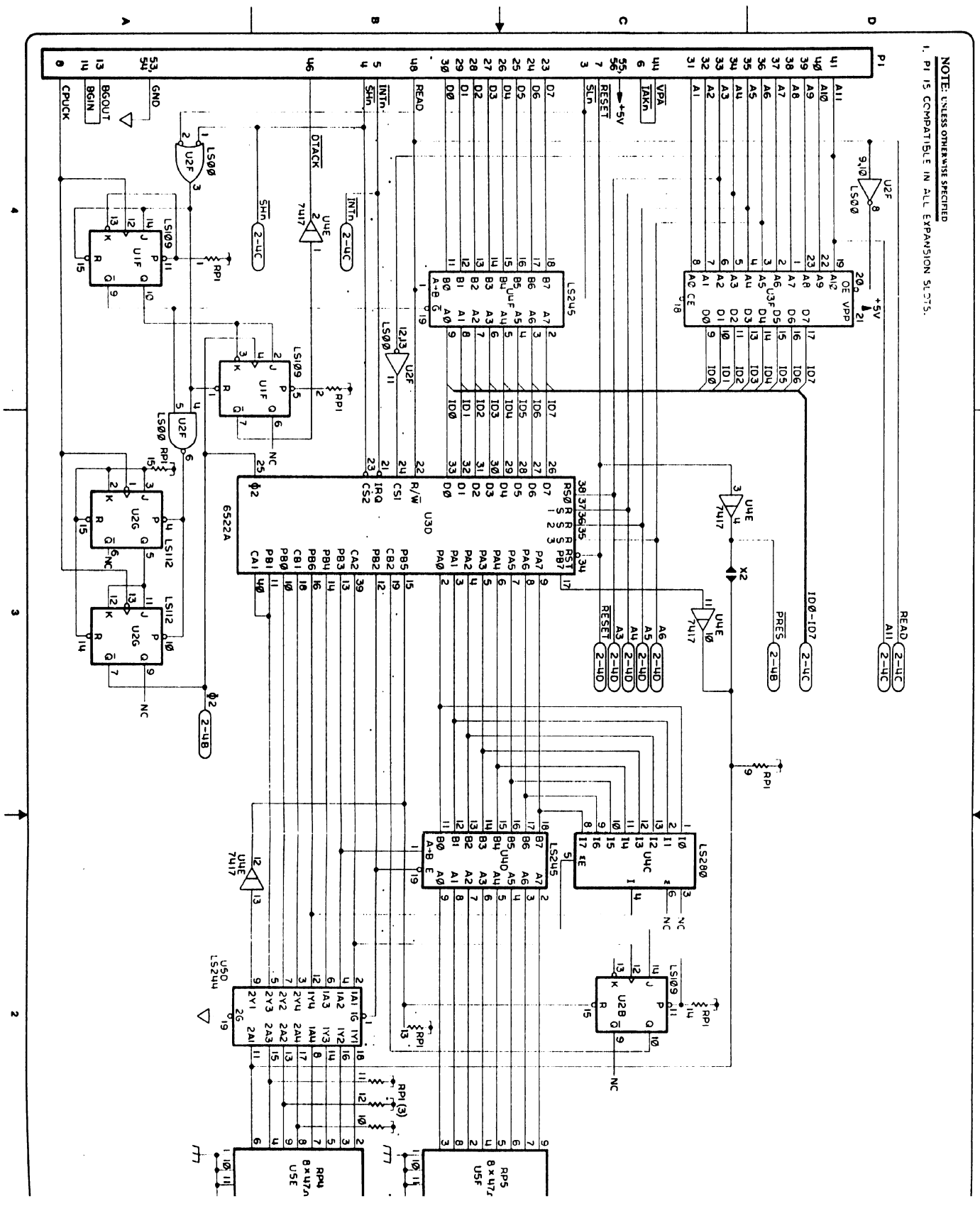

SEE SH 1
ANALOG CIRCUITS
CONTRAST LATCH
SPEAKER AMP
SCHEMATIC SYSTEM I/O LISA
050-4008-L
5/5
NOTE: UNLESS OTHERWISE SPECIFIED

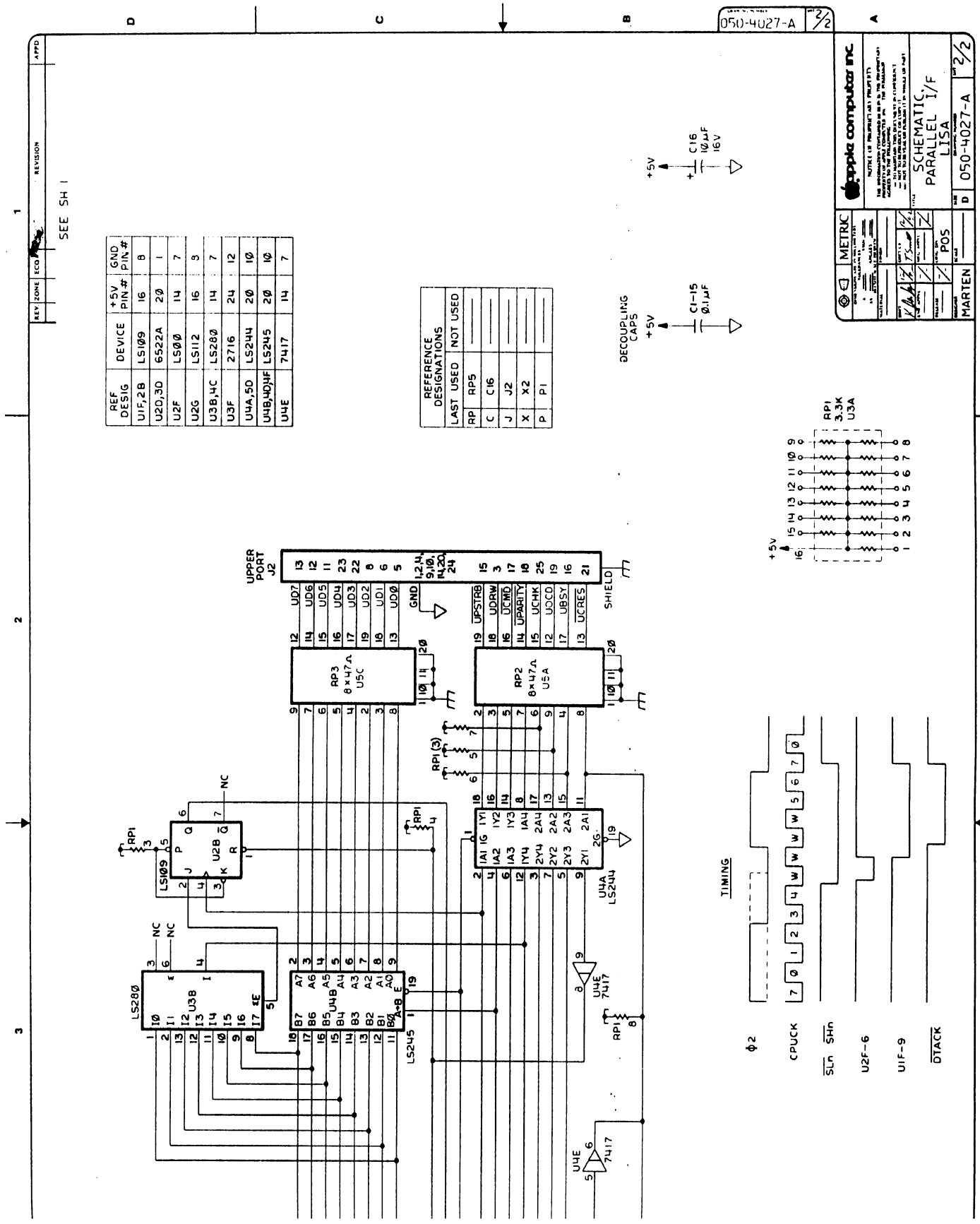

050-4010-B
apple computer inc
SCHEMATIC
MEMORY BOARD
LISA
050-4010-B
INITIAL RELEASE
SHT1-U13C WAS NAND GATE. ADDED HI TO PIN 11 U11C, U11B, PIN 15 U13A, PIN 4 Y5 U12B AND PIN 1 U13A.
SHT2-DOB-DO15 WAS D8-D15 ADDED D8-D15 TO U11B, U11C, U11X32 UPPER AND LOWER BYTE WAS 0.1 X 36. ADDED HI TO PIN 11 U13E, U12E.
SHT3-DOB-DO15 WAS D8-D15 64K RAM DETAIL WAS A5. 64 K RAM DETAIL WAS A5, A6. A2, A4 WAS A1 K AS WAS A6.
SHT4-64K RAM DETAIL WAS SAME AS SHEET 3.
NOTE: UNLESS OTHERWISE SPECIFIED
1. ALL CAPACITORS ARE IN μF.
2. FOR 512K MEMORY, ALL RAM ARE USED. USE BILL OF MATERIAL 620-0112.
3. FOR 256K MEMORY, ONLY RAM IN ROWS B AND C ARE USED. USE BILL OF MATERIAL 620-0156.
NEXT USE OF REFERENCE DESIGNATION USED
C9F L2 R2 RP6
SPARES

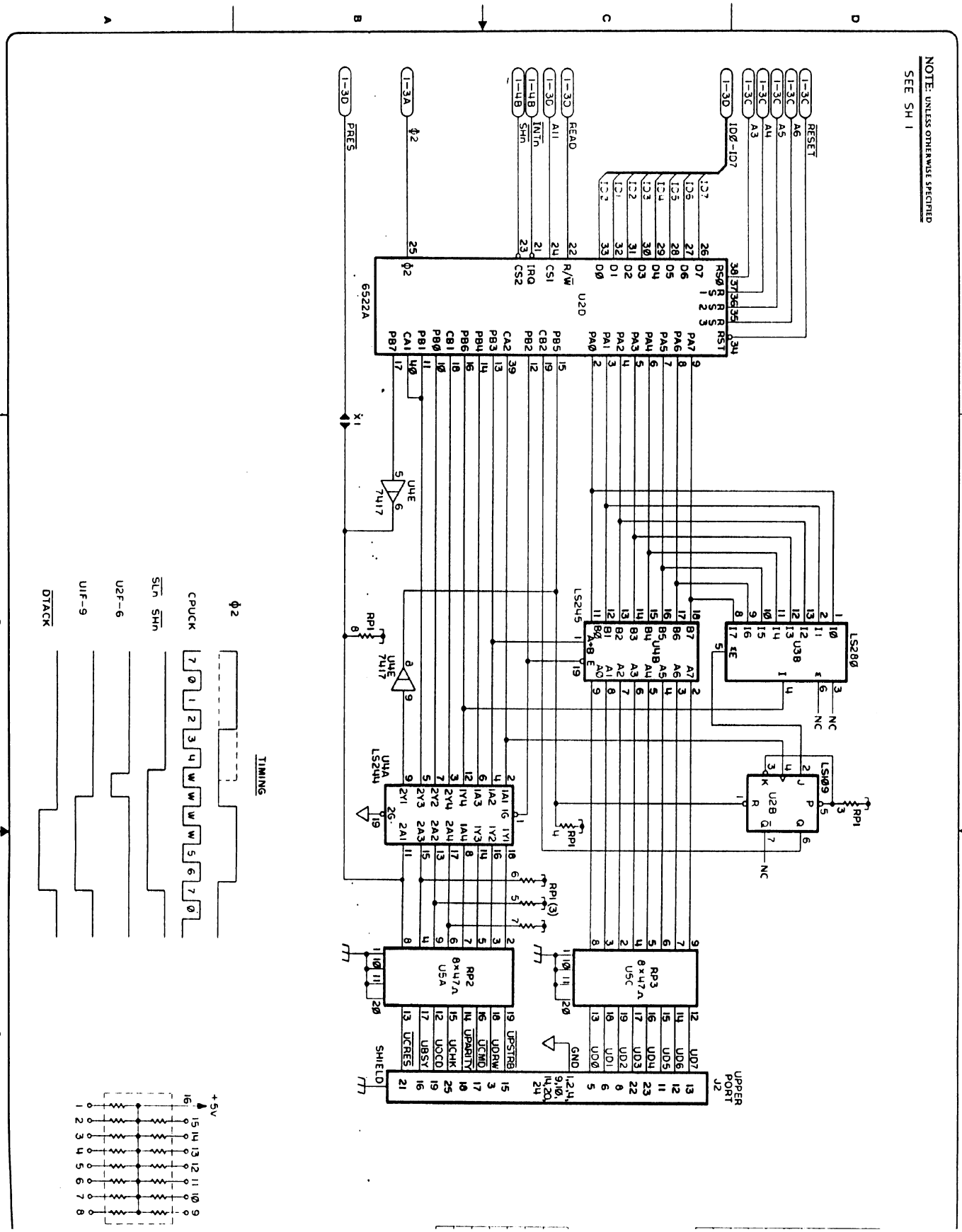

LOWER BYTE
UPPER BYTE
SEE SHEET 1
NOTE: UNLESS OTHERWISE SPECIFIED
SCHEMATIC
MEMORY BOARD
LISA
050-4010-B
METRIC
RQS
NONE
FITCH


050-4010-B
SCHEMATIC
MEMORY BOARD
LISA
UPPER BYTE
DETAIL FOR ALL 64K RAM
SEE SHEET 1
NOTE: UNLESS OTHERWISE SPECIFIED


050-4027-A 1/2
REV ZONE ECO # REVISION APPD
A — B178 INITIAL RELEASE —
apple computer inc
METRK
POS
MARTEN
SCHEMATIC, PARALLEL I/F LISA
D 050-4027-A 1/2
LOWER PORT J1
SHIELD
RP5 8 x 47Ω U5F
RP4 8 x 47Ω U5E
RP1 (3)
U5D LS244
U4C LS280
U28 LS109
U4D LS245
U4E 7417
U3D 6522A
X2
U2G LS112
U2F LS00
READ A11 ID0-ID7 PRES RESET A6 A5 A4 A3
Φ2 (2-48)
LPSTRB LDRW LCMD LPARITY LCHK LCOD LBSY LCRES
LD7 LD6 LD5 LD4 LD3 LD2 LD1 LD0
GND
NC


NOTE: UNLESS OTHERWISE SPECIFIED
1. P1 IS COMPATIBLE IN ALL EXPANSION SLOTS.
P1
CPUCK
BGOUT
BGIN
GND
+5V
RESET
VPA
TAKn
INTn
SHn
DTACK
READ
LS00
LS09
LS10
LS12
LS20
LS244
LS245
74LS17
6522A
RPI
RPI (3)
RP4 8x47Ω U5E
RP5 8x47Ω U5F
X2
PRES
NC


050-4027-A
SCHEMATIC, PARALLEL I/F LISA
050-4027-A
MARTEN
SEE SH 1
REFERENCE DESIGNATIONS
DECOUPLING CAPS
UPPER PORT J2
TIMING
Φ2
CPUCK
U2F-6
U1F-9
DTACK


NOTE: UNLESS OTHERWISE SPECIFIED
SEE SH 1
6522A
U2D
LS245
LS280
LS109
U4A LS244
RP1
RP1 (3)
RP2 8×47Λ U5A
RP3 8×47Λ U5C
UPPER PORT J2
SHIELD
GND
+5V
TIMING
CPUCK
SLn SHn
U2F-6
U1F-9
DTACK
φ2
PRES
RESET
READ
INTn
SHn
IRQ
CS1
CS2
R/W
RS0
RS1
RS2
RS3
RST
UPSTRB
UDRW
UCMD
UPARITY
UCHK
UDCD
UBSY
UCRES
UD0
UD1
UD2
UD3
UD4
UD5
UD6
UD7

Apple Computer Design Patent

Lisa Computer Case

United States Patent [19]

Dresselhaus et al.

[11] **Patent Number: Des. 277,673**

[45] **Date of Patent: ** Feb. 19, 1985**

[54] COMPUTER

[75] Inventors: **William F. Dresselhaus**, Redwood City; **Kenneth S. Campbell**, Mountain View; **Clive R. Twyman**, Fremont, all of Calif.; **Douglas C. Dayton**, Cambridge, Mass.

[73] Assignee: **Apple Computer, Inc.**, Cupertino, Calif.

[**] Term: **14 Years**

[21] Appl. No.: **387,029**

[22] Filed: **Jun. 10, 1982**

[52] **U.S. Cl.** **D14/106**

[58] **Field of Search** D14/100-116; 340/700, 711, 720

[56] **References Cited**

U.S. PATENT DOCUMENTS

D. 218,436 8/1970 Morgan et al. D14/108
D. 227,256 6/1973 Conway et al. D14/106
D. 227,772 7/1973 Carroll et al. D14/100

OTHER PUBLICATIONS

Infosystems, 5-1980, p. 61, Burroughs Word Processor.
Lanier® Super No Problem™ Typewriter Brochure © 1981, Word Processor.

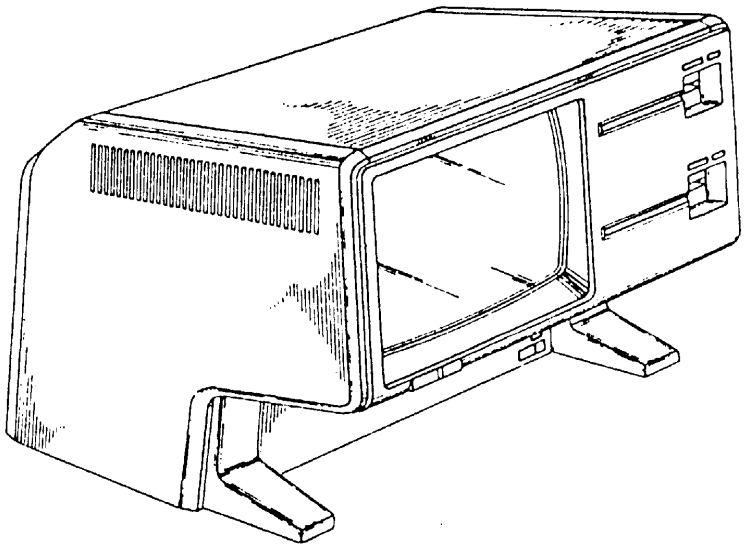
Primary Examiner—Susan J. Lucas
Attorney, Agent, or Firm—Blakely, Sokoloff, Taylor & Zafman

[57] CLAIM

The ornamental design for a computer, substantially as shown.

DESCRIPTION

FIG. 1 is a perspective view of a computer showing our new design;
FIG. 2 is a front elevational view thereof;
FIG. 3 is a top plan view thereof;
FIG. 4 is a right side elevational view thereof;
FIG. 5 is a rear elevational view thereof; and,
FIG. 6 is a left side elevational view thereof.



Apple Lisa computer

DAVID T. CRAIG

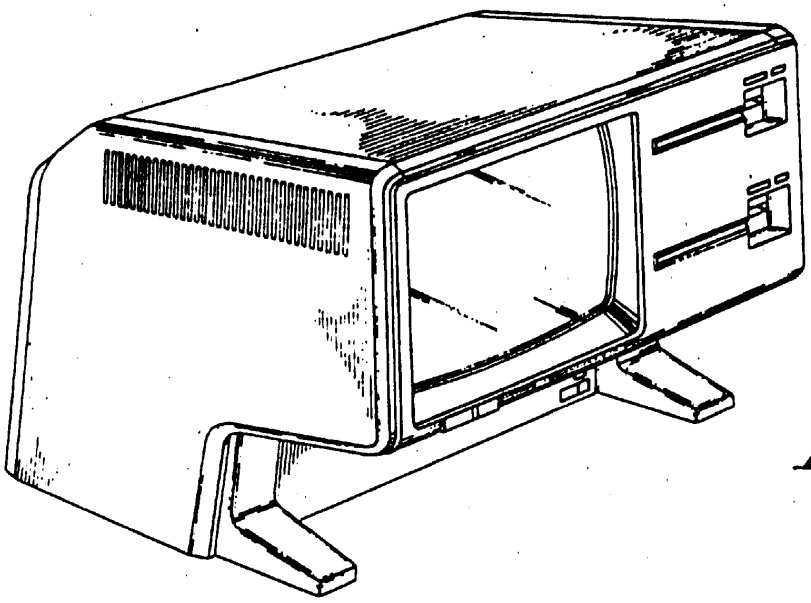


Fig. 1

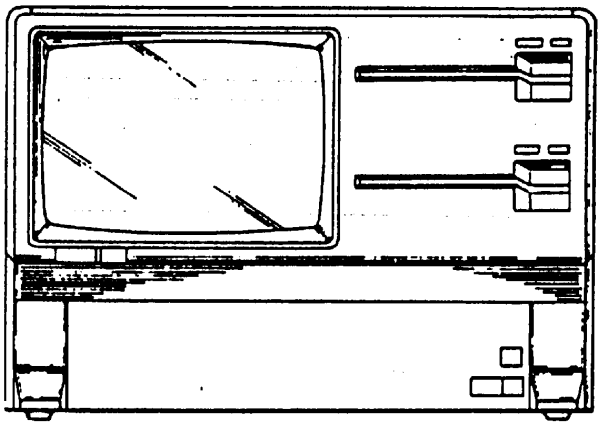


Fig. 2

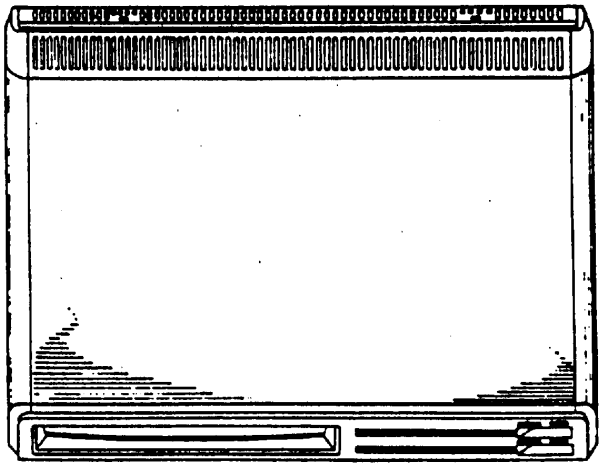


Fig. 3

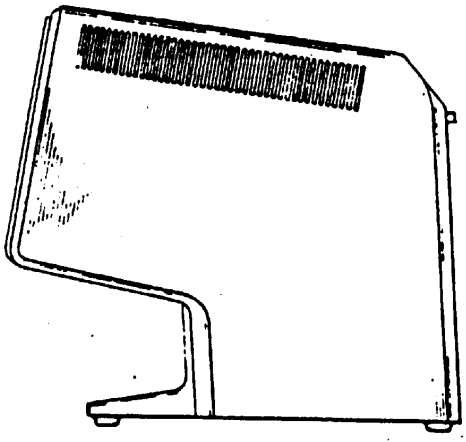


Fig. 4

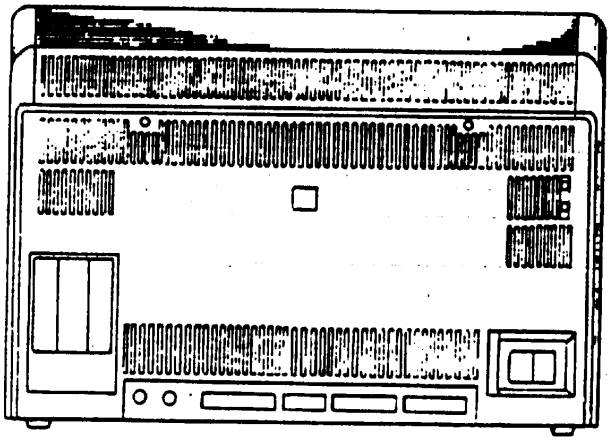


Fig. 5

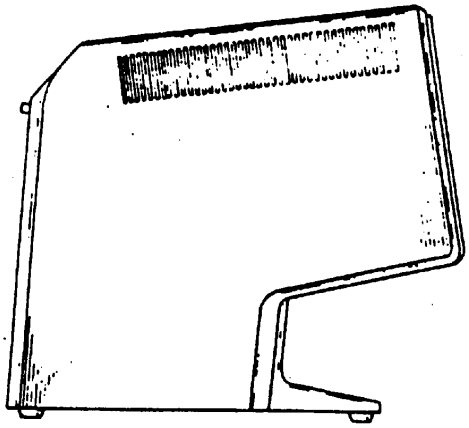


Fig. 6

Apple Computer Design Patent

ProFile Hard Drive Case

United States Patent [19]

Stewart

[11] **Des. 273,295**

[45] ** **Apr. 3, 1984**

[54] **HARD DISK DRIVE**

[75] Inventor: **James R. Stewart, San Jose, Calif.**

[73] Assignee: **Apple Computer, Inc., Cupertino, Calif.**

[**] Term: **14 Years**

[21] Appl. No.: **322,922**

[22] Filed: **Nov. 19, 1981**

[52] **U.S. Cl.** **D14/109**

[58] **Field of Search** D14/100-116; D13/41; 361/380, 390, 394; 360/97, 98, 133; 364/900

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,789,273	1/1974	O'Brien	360/97 X
3,899,794	8/1975	Brown, Jr.	D14/109 X

OTHER PUBLICATIONS

North Star Computers, Inc., Catalog, 5-1980, p. 8, Hard Disk Drive.

Radio Shack TRS-80™ Microcomputer Catalog RSC-3, ©1979, p. 10, VOXBOX™ Housing.

Primary Examiner—Susan J. Lucas

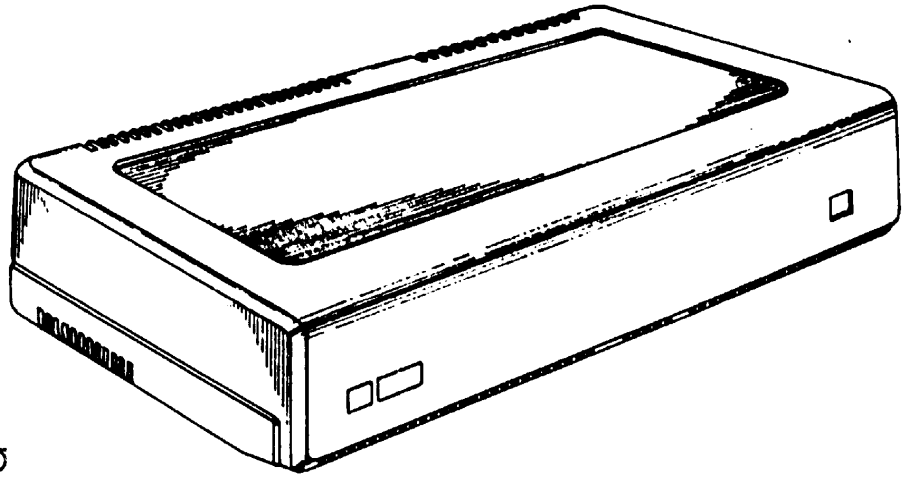
Attorney, Agent, or Firm—Blakely, Sokoloff, Taylor & Zafman

[57] **CLAIM**

The ornamental design for a hard disk drive, substantially as shown and described.

DESCRIPTION

FIG. 1 is a perspective view of the hard disk drive showing my new design;
FIG. 2 is a top view thereof;
FIG. 3 is a front view thereof;
FIG. 4 is a rear view thereof;
FIG. 5 is a right side view thereof; and
FIG. 6 is a left side view thereof.



DAVID T. CRAIG

Apple "ProFile" hard disk

(for Apple 3 and Lisa)

U.S. Patent Apr. 3, 1984 Sheet 1 of 2 Des. 273,295

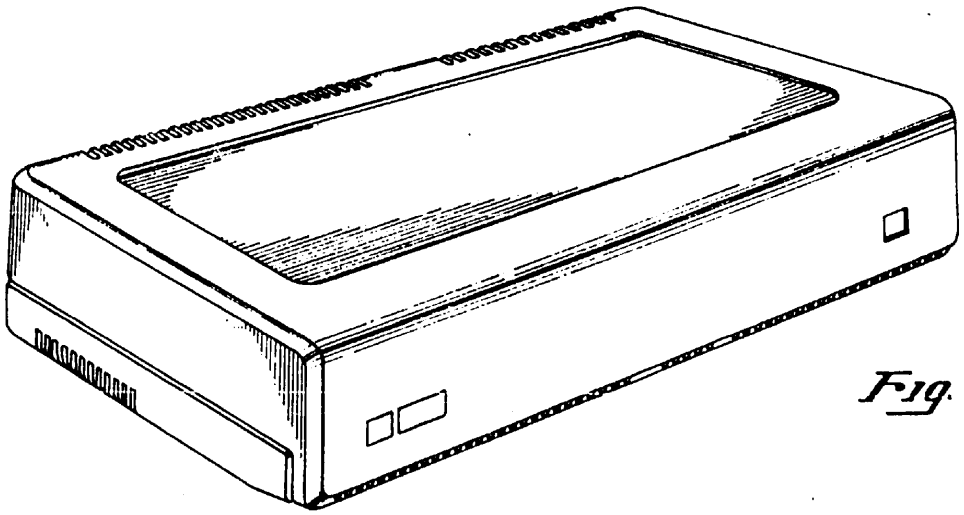


Fig. 1

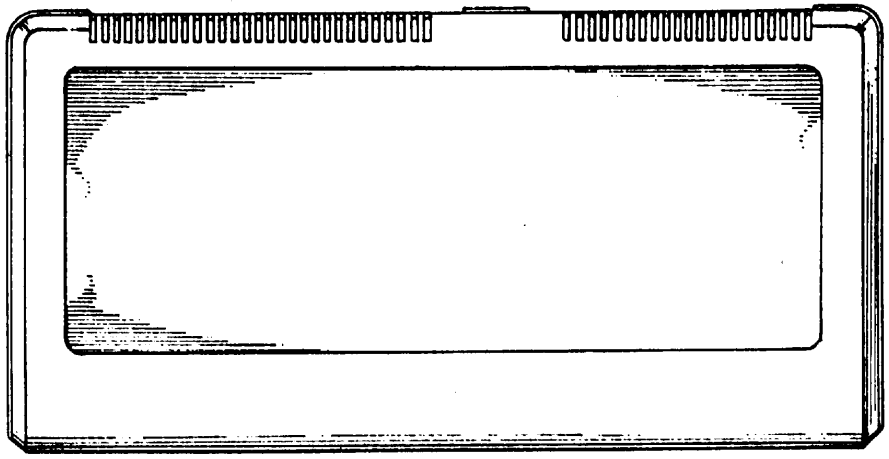


Fig. 2

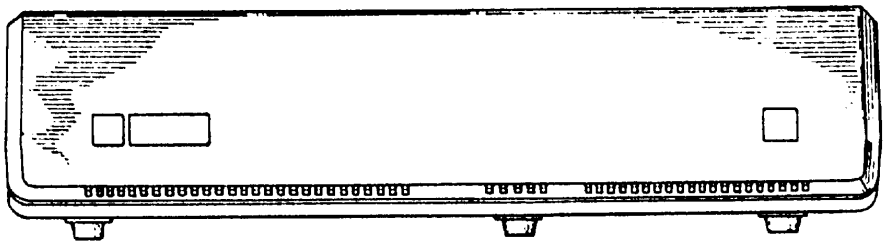
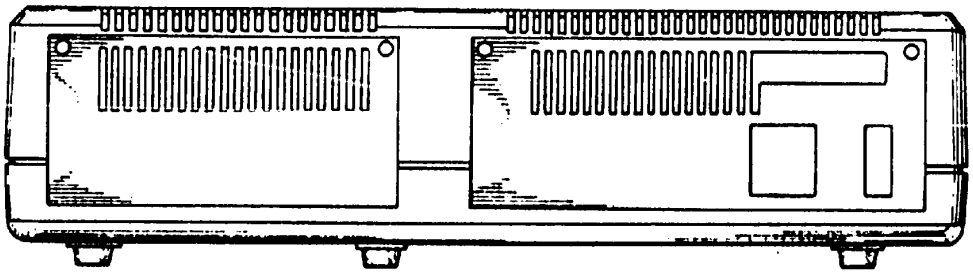


Fig. 3

Fig. 4



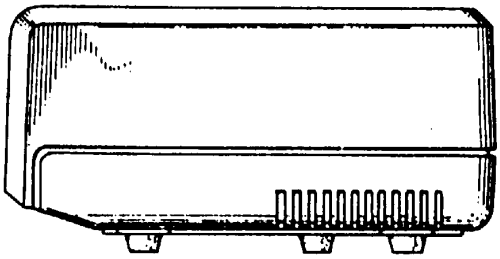


Fig. 5

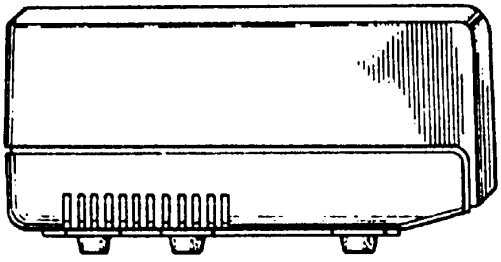


Fig. 6

Apple Computer Design Patent

Twiggy Floppy Disk Front Panel

United States Patent [19]

Dresselhaus

[11] **Des. 266,426**

[45] ** **Oct. 5, 1982**

[54] **FRONT PANEL FOR FLOPPY DISC DRIVE**

[75] Inventor: **William F. Dresselhaus**, Redwood City, Calif.

[73] Assignee: **Apple Computer, Inc.**, Cupertino, Calif.

[**] Term: **14 Years**

[21] Appl. No.: **161,274**

[22] Filed: **Jun. 20, 1980**

[51] **Int. Cl.** ..... **D14—02**
[52] **U.S. Cl.** **D14/115**; D14/109
[58] **Field of Search** D14/105, 107, 108, 109, D14/114, 115, 100, 102, 106; 360/97, 98, 99, 102, 133

[56] **References Cited**

U.S. PATENT DOCUMENTS

D. 249,343 9/1978 Ronzani D14/115

OTHER PUBLICATIONS

Computer Design, 7/78, p. 145, Persci Diskette Drive.
Computer Design, 12/78, p. 11, Data Systems, Floppy Disk System, DSD110 MOD.
General Electric Co., Terminet® DST Brochure, 5/78, Diskette Storage Terminal.

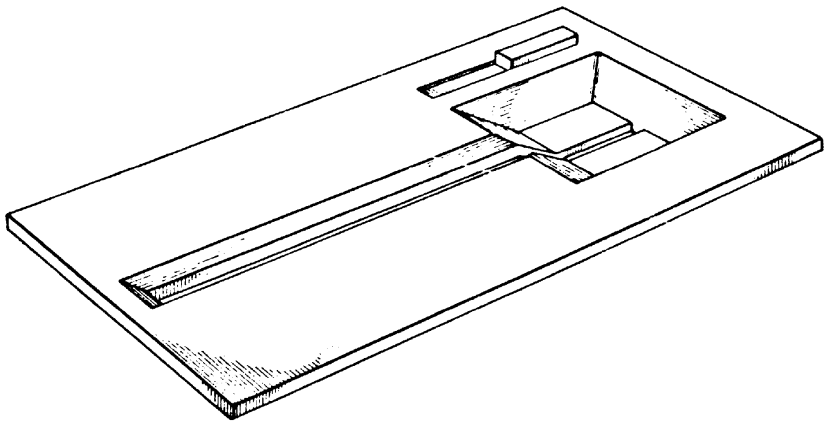
Primary Examiner—Susan J. Lucas
Attorney, Agent, or Firm—Blakeley, Sokoloff, Taylor & Zafman

[57] **CLAIM**

The ornamental design for a front panel for floppy disc drive, as shown and described.

DESCRIPTION

FIG. **1** is a perspective view of the front panel for a floppy disc drive showing my new design.
FIG. **2** is a front elevational view thereof;
FIG. **3** is a bottom view thereof;
FIG. **4** is a rear elevational view thereof;
FIG. **5** is a top view thereof;
FIG. **6** is a left side view thereof; and,
FIG. **7** is a right side view thereof;
FIG. **8** is a perspective view of an alternate embodiment of the front panel of FIGS. **1** through **7**;
FIG. **9** is a front elevational view thereof;
FIG. **10** is a bottom view thereof;
FIG. **11** is a rear elevational view thereof;
FIG. **12** is a top view thereof;
FIG. **13** is a left side view thereof; and,
FIG. **14** is a right side view thereof.



Lisa computer's front panel for "Twiggy" floppy drive

DAVID T. CRAIG

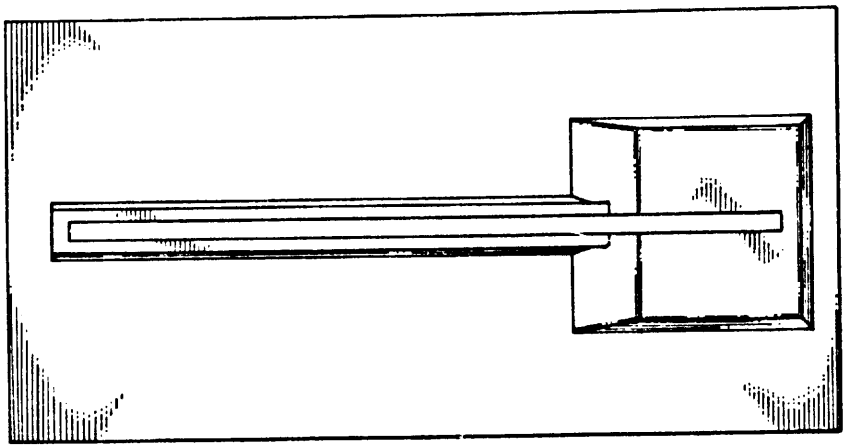


Fig. 4

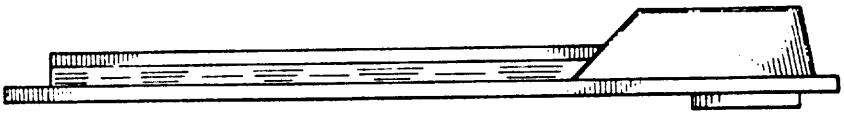


Fig. 5

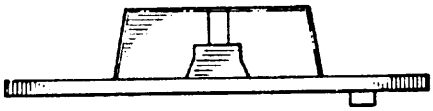


Fig. 6

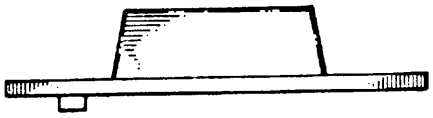


Fig. 7

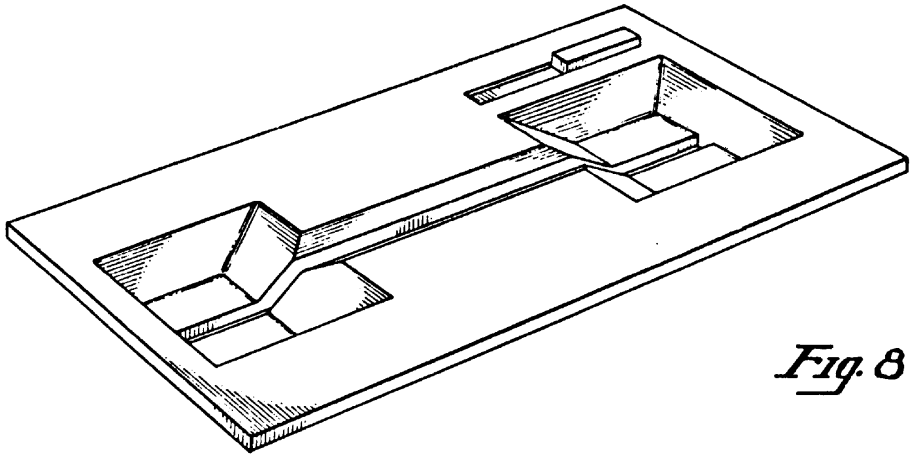


Fig. 8

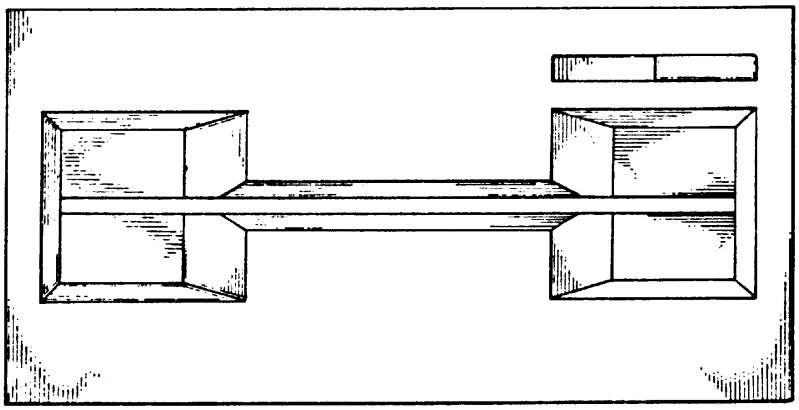


Fig. 9

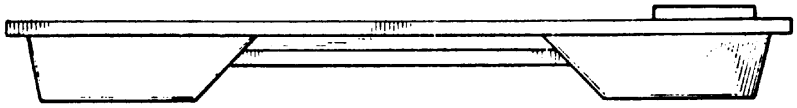
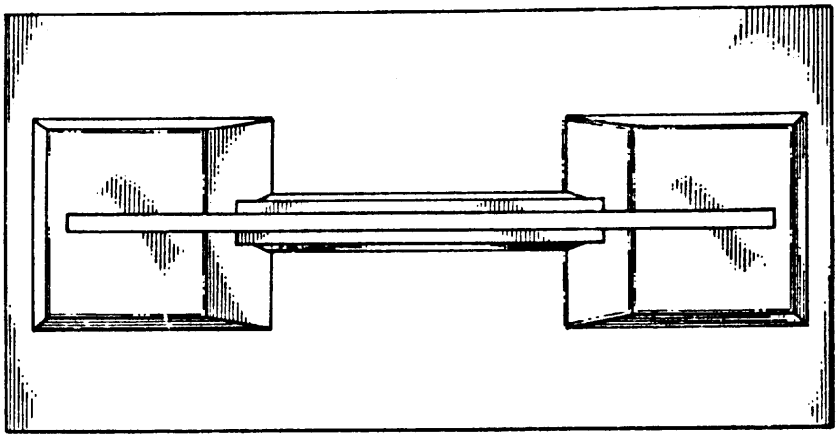


Fig. 10

Fig. 11



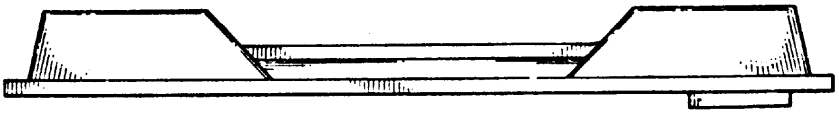


Fig. 12

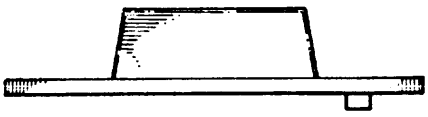


Fig. 13

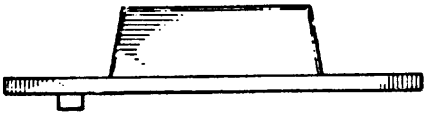


Fig. 14

Apple Computer Patent

Memory Management Unit (MMU)

United States Patent [19]

Baker et al.

[11] **Patent Number: 4,926,316**

[45] **Date of Patent: May 15, 1990**

[54] **MEMORY MANAGEMENT UNIT WITH OVERLAPPING CONTROL FOR ACCESSING MAIN MEMORY OF A DIGITAL COMPUTER**

[75] Inventors: **Paul A. Baker**, Los Altos; **Gary L. Marten**, Cupertino, both of Calif.

[73] Assignee: **Apple Computer, Inc.**, Cupertino, Calif.

[21] Appl. No.: **933,071**

[22] Filed: **Dec. 17, 1986**

Related U.S. Application Data

[63] Continuation of Ser. No. 426,869, Sep. 29, 1982, abandoned.

[51] **Int. Cl.**[5] **G06F 9/00**

[52] **U.S. Cl.** **364/200**; 364/238.4; 364/246; 364/246.3; 364/246.4; 364/246.5; 364/245.4

[58] **Field of Search** 364/200, 900

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,828,327	8/1974	Berglund et al.	340/172.5
3,902,163	8/1975	Amdahl et al.	340/172.5
4,004,278	1/1977	Nagashima	340/172.5
4,037,215	7/1977	Birney et al.	364/200
4,084,224	4/1978	Appell et al.	364/200
4,084,227	4/1978	Bennett et al.	364/200
4,084,228	4/1978	Dufond et al.	364/200
4,096,568	6/1978	Bennett et al.	364/200
4,104,718	8/1978	Poublan et al.	364/200
4,130,867	12/1978	Bachman et al.	364/200
4,297,743	10/1981	Appell et al.	364/200
4,316,245	2/1982	Luu et al.	364/200
4,354,225	10/1982	Frieder et al.	364/200
4,376,297	3/1983	Anderson et al.	364/200
4,378,591	3/1983	Lemay	364/200
4,410,941	10/1983	Barrow et al.	364/200
4,424,561	1/1984	Stanley et al.	364/200

FOREIGN PATENT DOCUMENTS

0040702	2/1981	European Pat. Off. .
190324	12/1982	New Zealand .
1413739	11/1975	United Kingdom .
1477977	6/1977	United Kingdom .
1487078	9/1977	United Kingdom .
1498116	1/1978	United Kingdom .
1547382	6/1979	United Kingdom .
1557121	12/1979	United Kingdom .
1577592	10/1980	United Kingdom .
1585960	3/1981	United Kingdom .
2073458	2/1984	United Kingdom .

OTHER PUBLICATIONS

Wescon Conference Record, vol. 25, Sep. 1981, pp. 1–9, El Segundo, U.S.; S. Walters: "Memory Management Made Easy with the Z8000".

Electronic Design, vol. 29, No. 17, Aug. 1981, pp. 115–121, Waseca, MN, U.S.; D. L. Collins et al.: "Memory Management Chip Masters Large Data Bases".

Electronics International, vol. 54, No. 11, Jun. 1981, pp. 134–138, New York, U.S.; J. Beekmans et al.: "Chip Set Bestows Virtual Memory on 16-bit Minis".

Primary Examiner—Gareth D. Shaw

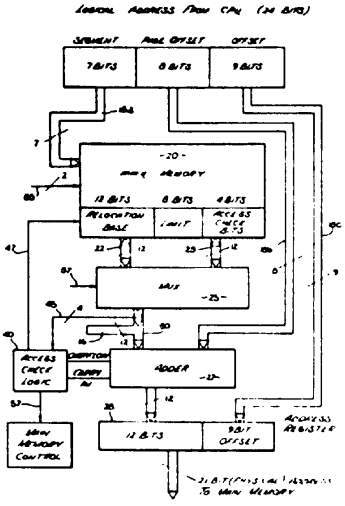
Assistant Examiner—John G. Mills

Attorney, Agent, or Firm—Blakely, Sokoloff, Taylor & Zafman

[57] **ABSTRACT**

An improved memory management unit (MMU) for interfacing between a CPU and a main computer memory. The MMU receives logical addresses from the CPU and converts a portion of the logical address to be used for generating a physical address to address to address the main memory. The MMU memory contains relocation data which is stored in a plurality of segments known as contexts. For a given logical address provided by the CPU, the CPU also selects an appropriate context so that the mapping of the main memory is determined by the selected relocation base. This permits relocation data to be stored for a plurality of processes and thus, allows several programs to be run without reprogramming the MMU. Special "limit" bits and "access" bits are also stored in the MMU's memory for each of the relocation base data. The limit bits are used to check the range of the memory area requested for a given context to determine if it is in the allowable range. Access bits are used to determine if the type of access being requested is a legal access for the given context. Because the MMU stores a number of relocation bases which are programmable by the CPU, areas of main memory can be accessed by more than one context, thereby providing an overlapped mapping of the main memory. For example, in a supervisory mode the supervisory context is able to access all of the main memory.

5 Claims, 3 Drawing Sheets



DAVID T. CRAIG

Lisa MMU

U.S. Patent May 15, 1990 Sheet 1 of 3 4,926,316

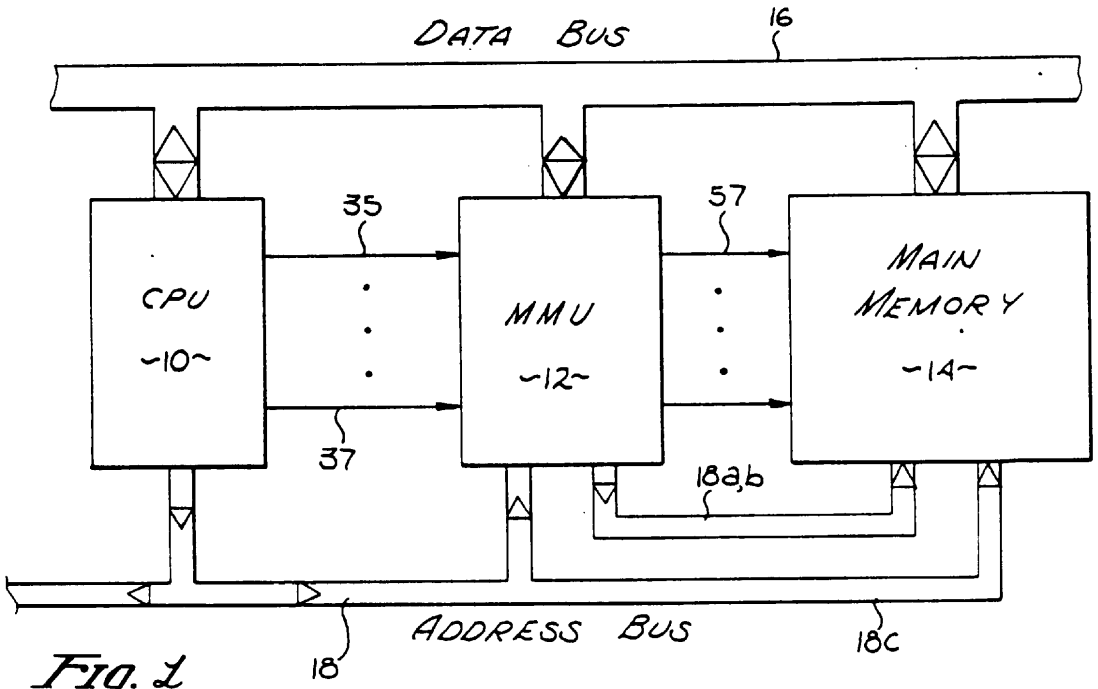


Fig. 1

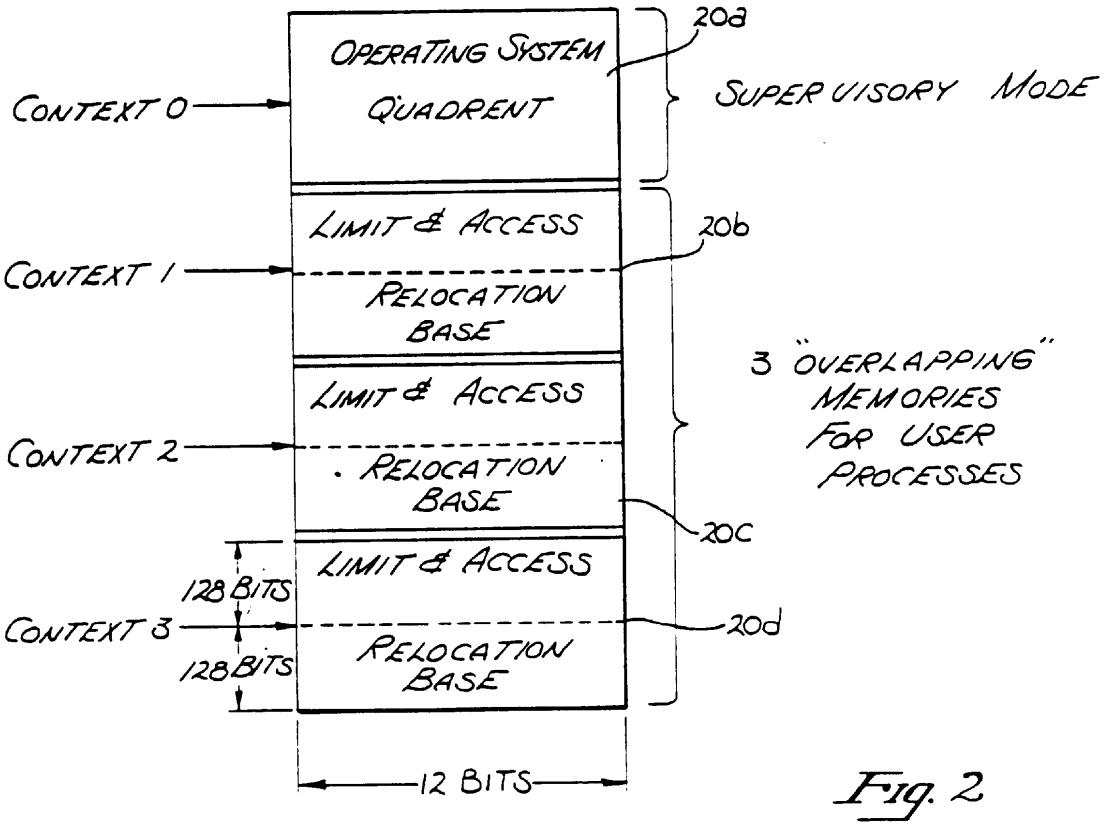
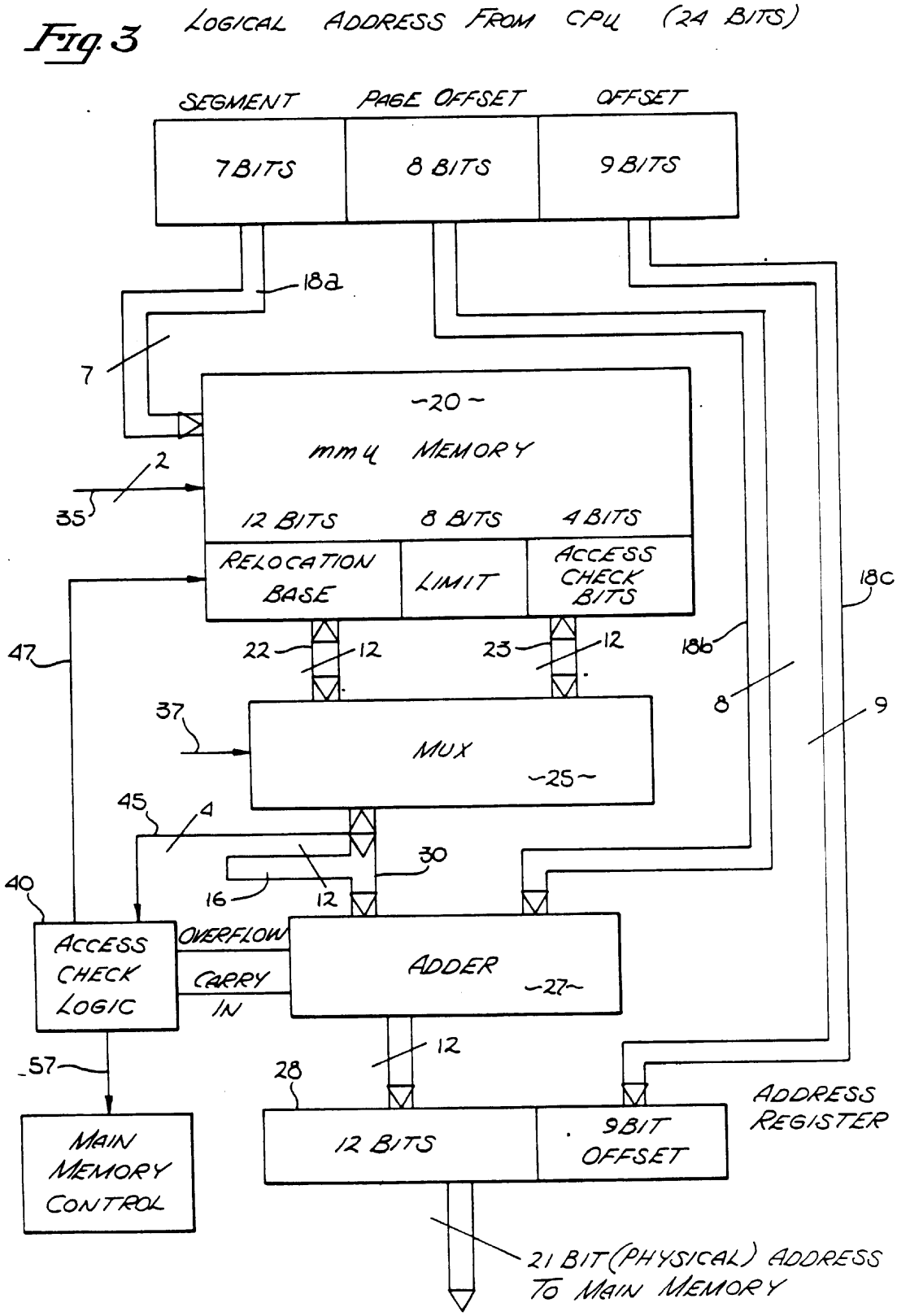


Fig. 2

Fig. 3


LOGICAL ADDRESS FROM CPU (24 BITS)
SEGMENT
PAGE OFFSET
OFFSET
7 BITS
8 BITS
9 BITS
18a
7
-20-
mmu MEMORY
2
35
12 BITS
8 BITS
4 BITS
RELOCATION BASE
LIMIT
ACCESS CHECK BITS
18c
47
22
12
23
12
18b
8
9
37
MUX
-25-
45
4
30
40
16
12
ACCESS CHECK LOGIC
OVERFLOW
CARRY IN
ADDER
-27-
57
12
28
ADDRESS REGISTER
MAIN MEMORY CONTROL
12 BITS
9 BIT OFFSET
21 BIT (PHYSICAL) ADDRESS TO MAIN MEMORY

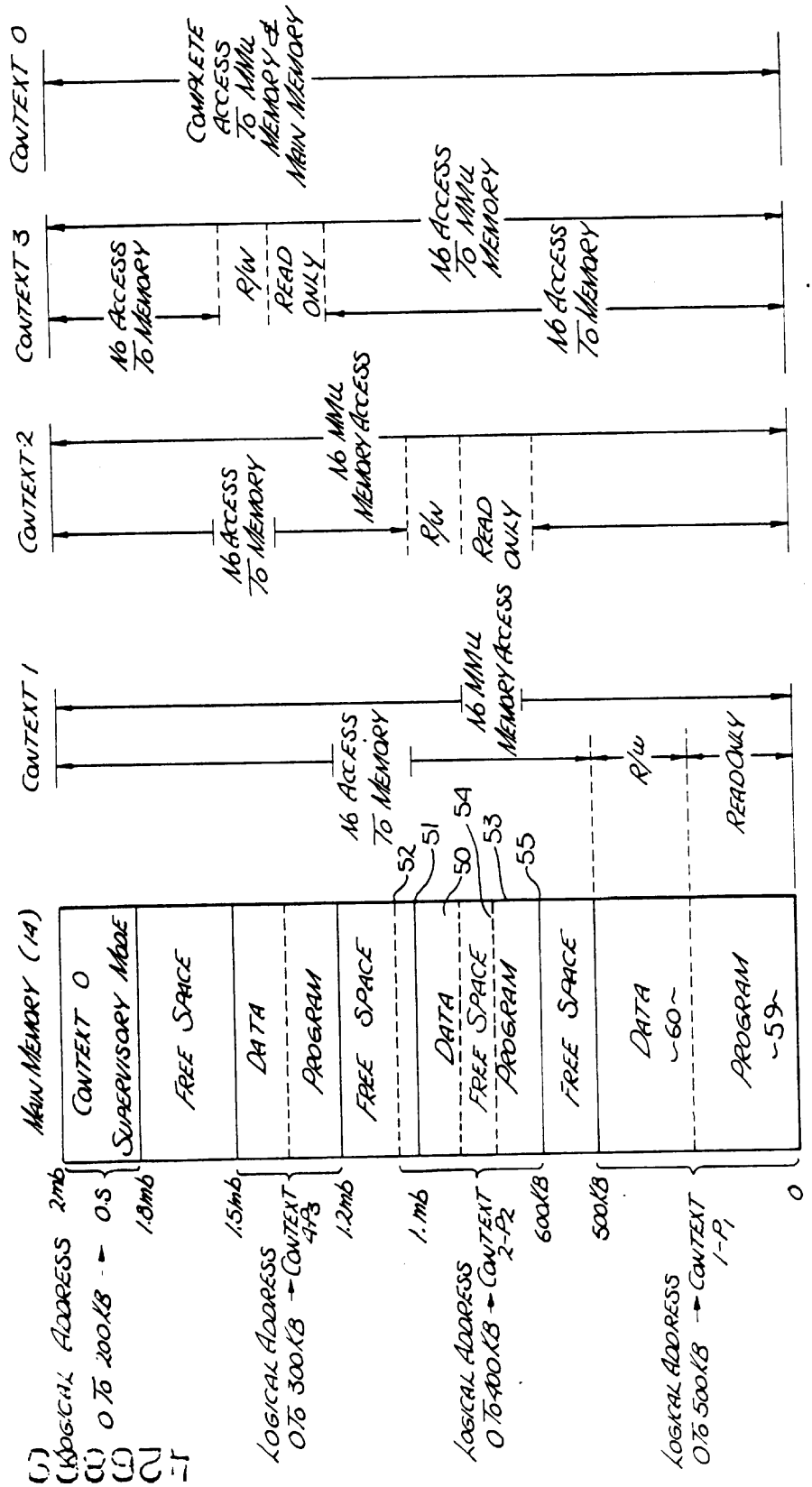

MAIN MEMORY (14)
CONTEXT 0
SUPERVISORY MODE
FREE SPACE
DATA
PROGRAM
FREE SPACE
DATA
FREE SPACE
PROGRAM
FREE SPACE
DATA
~60~
PROGRAM
~59~
2mb
1.8mb
1.5mb
1.2mb
1.mb
600KB
500KB
0
LOGICAL ADDRESS 0 TO 200KB → CONTEXT 0-.5
LOGICAL ADDRESS 0 TO 300KB → CONTEXT 4-3
LOGICAL ADDRESS 0 TO 400KB → CONTEXT 2-P2
LOGICAL ADDRESS 0 TO 500KB → CONTEXT 1-P1
CONTEXT 1
CONTEXT 2
CONTEXT 3
CONTEXT 0
NO ACCESS TO MEMORY
NO MMU MEMORY ACCESS
R/W
READ ONLY
NO ACCESS TO MMU MEMORY
COMPLETE ACCESS TO MMU & MEMORY & MAIN MEMORY
52
51
50
54
53
55

Fig. 4

MEMORY MANAGEMENT UNIT WITH OVERLAPPING CONTROL FOR ACCESSING MAIN MEMORY OF A DIGITAL COMPUTER

This is a continuation of application Ser. No. 426,869 filed Sept. 29, 1982.

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The invention relates to the field of computer memories and units for managing the contents of such memories.

2. Prior Art

In most computers, a central processing unit (CPU) communicates directly with both an address bus and a data bus. These buses are coupled to a main memory (or main memory systems) in addition to numerous other items such as input/output ports, specialized processors, DMA units, etc. The main computer memory is often the most expensive component of the computer, particularly when compared to the price of currently available microcomputer CPUs such as the 8080, 8086, 6800 and 68000. Thus, it is important to efficiently utilize the computer's main memory.

Memory management units (MMUs) are used in the prior art to provide efficient utilization of the computer's main memory. These units perform housekeeping functions such as remapping, etc. Often, an MMU includes a memory which stores a data relocation base The higher order bits of the logical address from the CPU are used to address the MMU's memory. These bits from the CPU's standpoint, for instance, select a segment of the main memory. The selected CPU segment number is replaced by a new number from the MMU's memory and effectively, a relocation occurs between the logical address from the CPU and the physical address used to access the main memory.

Another function performed by prior art MMUs is to check addresses from the CPU to verify that they fall within certain ranges. A limit number stored in the MMU's memory is compared with lower order bits of the logical address (for example, the page offset) to assure that the page offset falls within a predetermined address range of the selected segment number. This prevents, by way of example, the accidental reading of "data" from memory locations where data has not been placed.

The present invention builds upon those prior art MMUs which provide a relocation base and address range verification. As will be seen, the MMU's memory is expanded in one direction to store signals representing the nature of information stored in the main memory. This is used to control access of the main memory and, by way of illustration, prevents accidental writing into programs and user access to operating systems. The MMU's memory is expanded in another direction so that overlapping memory management is provided. This allows several different processes (program and data) to be run by the computer without reprogramming the MMU memory.

SUMMARY OF THE INVENTION

An improved memory management unit (MMU) is described for use with a computer which includes a central processing unit (CPU) and a main memory. The MMU includes a relocation base and when receiving first address signals from the CPU, provides second

address signals for accessing the memory. The MMU also includes storage means for receiving and storing signals representative of the types of information stored in locations in the main memory. Accessing means are provided for accessing these stored signals when the corresponding locations are accessed in the main memory. The stored signals from the storage means are coupled to the main memory to, for example, limit access of certain types of data in the memory such as operating systems. The signals may be also used to permit reading-only of programs, and reading and writing of data.

In the presently preferred embodiment, the storage means is an integral part of the MMU's memory. The MMU's memory has four times the capacity than is needed to provide relocation base numbers and limit numbers for the entire main memory. As will be described, this additional capacity permits a form of "bank switching" and allows different processes to be run on the computer without reprogramming of the MMU memory.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a general block diagram illustrating a central processing unit, memory management unit (MMU) and main memory and their interconnections in a computer.

FIG. 2 is a diagram illustrating the organization of data stored in the memory of the invented MMU.

FIG. 3 is a block diagram of the invented MMU.

FIG. 4 is a diagram used to describe the different contexts used in the operation of the MMU and the resultant organization of information stored in the computer's main memory

DETAILED DESCRIPTION OF THE INVENTION

A memory management unit (MMU) is described for use in a digital computer which includes a central processing unit (CPU) and a main memory. In the following description, numerous specific details are set forth such as specific memory sizes, part numbers, etc., in order to provide a thorough understanding of the present invention. However, it will be obvious to one skilled in the art that these specific details are not required to practice the present invention. In other instances, well-known structures and circuits are not described in detail in order not to obscure the present invention in unnecessary detail.

Referring first to FIG. 1, the coupling between an MMU, CPU and main memory is illustrated This coupling is somewhat the same for the present invention as it is for the prior art. The computer of FIG. 1 includes a bidirectional data bus 16 which communicates with the CPU 10, main memory 14 and the MMU 12. The address bus 18 receives address signals from the CPU 10 and communicates part of these addresses to the MMU 12 and part to the main memory 14. Other control signals are coupled between the CPU 10 and MMU 12 as illustrated by lines 35 and 37 and between the MMU 12 and the main memory 14 as shown by line 57.

The MMU 12 is programmed from the CPU 10 through the data bus 16. Addresses are communicated over the bus 18 to the MMU from the CPU 10 to allow the loading of the MMU 12.

In the presently preferred embodiment, the CPU 10 comprises a 68000 processor. For this processor, the CPU 10 provides 24 bit addresses (Actually, the lowest

order bit is not physically present as such but encoded into other signals, however, for purposes of discussion, it will be assumed to be an ordinary address bit.) Also, for purposes of discussion, it will be assumed that the 7 highest order bits of each logical address from the CPU selects a segment in memory, the next 8 lesser significant bits comprise a page offset, and the least significant 9 bits, an offset.

In the presently preferred embodiment, the segment and page offset of each address are coupled to the MMU **12**. The MMU provides a relocation base by exchanging the segment number from the CPU **10** with a segment number stored in the MMU **12**. Specifically, the segment number from the CPU **10** addresses a memory within the MMU **12** and this memory provides a segment base used to address the main memory **14**. The page offset portion of the address from the CPU **10** is checked to determine if the page offset falls within a predetermined range of the segment. This, for instance, would prevent the reading and interpreting as data, all zeros from an unused space in main memory. The segment base from the MMU along with the page offset are added and then coupled to the main memory **14** on the bus **18***a* and **18***b* of FIG. **1**.

The 9 least significant bits are passed directly from the CPU to the main memory via bus **18***c*.

Referring now to FIG. **3**, the presently preferred embodiment of the MMU includes an MMU memory **20**. This memory is a random-access memory fabricated from commercially available MOS static RAMs. As currently implemented, three Part No. 2148 RAMs are used for memory **20**, thus providing a total capacity of 12k bits. The organization of the MMU memory is discussed in greater detail, particularly in conjunction with FIG. **2**.

The address from the CPU is shown as the 24 bit address (logical address) in the uppermost part of FIG. **3**. The 7 most significant bits of this address are coupled to the MMU's memory via bus **18***a* and are used to address the MMU's memory. The next most significant bits (bus **18***b*) are coupled to an adder **27**, and the least significant 9 bits (offset) are coupled via bus **18***c* to register **28**. The output of the MMU's memory **20** consists of two 12-bit words (buses **22** and **23**). These words are coupled through the multiplexer **25** to the 12-bit bus **30**. One of the 12 bit words from the memory **20** provides the segment base from the stored relocation base. The second 12 bits consist of 8 bits for limit checking of the page offset and 4 additional bits which perform functions which are part of the present invention.

(In the presently preferred embodiment, multiplexer **25** does not physically exist, rather the output of memory **20** is time division multiplexed. However, for purposes of explanation it is easier to include the multiplexer **25**.)

The multiplexer **25** is also used to load information from the bus **16** into the memory **20**. The signal on line **47** from the access check logic **40** provides access to the memory **20** as do the signals on line **35**. The signal on line **37** controls the multiplexing of data between either the bus **22** or the bus **23**.

The 12 bit bus **30** from the multiplexer **25** is coupled to the adder **27**. This adder also receives the 8 bits on bus **18***b*. As will be described, the adder **27** is used to determine if the page offset falls within a predetermined range of the selected segment. The adder **27** also combines the relocation (segment base) from the MMU's memory with the page offset to provide the 12 most significant bits of the physical address These 12 bits along with the 9 bits from bus **18***c* are coupled to the register **28** to provide a 21 bit address which is communicated to the main memory **14**. (The register **28** does not exist in the presently preferred embodiment, it is shown for purposes of explanation).

The 4 access check bits are coupled from the multiplexer **25** via line **45** to the access logic **40**. Here the signals are decoded to provide main memory control and other control as follows: One bit controls the type of main memory access (1=read only, 0=read/write}. The second bit controls I/o access (1=4I/o, 0 =no I/o access}. The third bit controls main memory access (1=memory access, 0=no main memory access). The fourth bit controls stacking (1=stack segment - check for no overflow, 0=normal segment - check for overflow). The access check logic **40** is shown in FIG. **3** coupled to the main memory control via line **57** to control memory access and the type of accesses permitted (i.e., read or read/write). Logic **40** is coupled to adder **27** via the overflow/carry in lines and to memory **20** via line **47** to enable memory **20** access.

The specific access control bit pattern used in the presently preferred embodiment is shown below.

ACCESS CONTROL BITS

MEM/ BITS	IO/	RO/	STK/	ADDRESS SPACE AND ACCESS
0	1	0	0	Main Memory - Read Only Stack
0	1	0	1	Main Memory - Read Only
0	1	1	0	Main Memory - Read/Write Stack
0	1	1	1	Main Memory - Read/Write
1	0	0	1	I/O Space
1	1	0	0	Page Invalid (segment not present)
1	1	1	1	Special I/O Space
Any other				Not allowed (unpredictable result)

Assume first that the memory **20** has been programmed from the CPU. For purposes of a first level explanation of the MMU's operation, the function of the 2 bits on lines **35** shall be ignored When the CPU addresses the main memory, the most significant 7 bits address the MMU's memory **20**. The 12 bits from the relocation data segment are coupled via bus **22** and bus **30** to the adder **27**. There they are combined with the page offset (bus **18***b*) and the resultant address is combined with the 9 bits of the offset in the register **28** to provide the final physical address. This portion of the MMU operates in a manner quite similar to prior art MMUs. Thus, the relocation segment base data can be programmed into the memory (ignoring line **35**) in a manner well-known in the prior art.

The 12 bits forming the limit and access data are coupled via bus **23** through the multiplexer **25**. The 8 bits of the limit data are coupled to the adder **27**. The 4 bits of the access data are coupled to logic **40** via line **45** as discussed. The limit data in the presently preferred embodiment is stored in ones complement form in the memory **20** for a non-stacked segment. For stacked segments the limit stored is "length minus one" (e.g. a two page segment would be stored as 0000 0001 in memory **20**.) When this limit data is added to the page offset in adder **27**, the result of this addition determines whether or not the page offset falls within the predetermined range of the segment. This is an improvement over prior art limit checking where additional logic steps are required

NON-STACK EXAMPLE

Referring briefly to FIG. 4, a representation of the computer's main memory 14 is illustrated. Assume that data is stored at locations 50. Further assume that the highest page offset (1111 1111) for data 50 extends to location 52, and that within this segment data extends to a page offset of 1110 0000 (line 51). For this page offset, the ones complement of 1110 0000 (0001 1111) is stored in the memory 20 of FIG. 3. If this segment is addressed, and assuming the page offset address is 1111 1111 (that is, into the free space of the memory), adder 27 adds 1111 1111 to the stored number 0001 1111. An overflow occurs from the adder 27 and this overflow condition is sensed by the logic 40 of FIG. 3. For this example, an overflow indicates that the page offset is not within range and a signal is provided on line 57 to show that the address is in error. Logic 40 via line 57 prevents access to main memory and/or an error signal is generated.

Again referring to FIG. 4, assume that a program is stored at locations 53 and that the highest page offset (1111 1111) for program 53 extends to location 50 which is outside of the actual program which ends at location 54. If the page offset for location 54 is 0011 0000 then 1100 1111 is stored within the memory 20 of FIG. 3 for the segment which begins at location 55. If this segment is addressed and the page offset is 0000 0001, (addressing the program) the adder 27 adds 1100 1111 and 0000 0001. This time no overflow occurs and no signal is communicated to the logic 40, that is, access is permitted. Note that if the page offset is 0100 0000 (not within range) when this number is added to the stored number of 1100 1111 an overflow occurs. This overflow indicates to the logic 40 that the page offset is not in range and memory access is disabled.

STACK EXAMPLE

For some programming languages (e.g. Pascal) stacks (in memory) are very desirable. Stacks can be formed by moving data up in memory, albeit time consuming. Stacks with the presently described system are permitted to grow down in memory with a different limit checking procedure.

Assume a one page stack segment. The limit number stored in memory 20 as the one's compliment of the page offset (1111 1111→0000 0000) which is the same as the size minus one (0000 0000→0000 0000). The access check bits causes the logic 40 to provide a carry-in of one. If the page offset is 1111 1111, an overflow occurs. This overflow is sensed by logic 40, and interpreted as a valid (within range) condition. If the page offset were 1111 1110 (stack grown too much), no overflow occurs and this is interpreted as an out of range address.

Similarly, if the stack is a two page segment, 0000 0001 is stored in memory 20. Again the carry in is set to a one. A page offset of 1111 1110 would result in an overflow indicating an in range address, whereas with a page offset of 1111 1100 no overflow would occur, indicating an out of range address.

FIG. 4 EXAMPLE

Referring again to FIG. 4, assume that a process (program and data) is stored in the main memory 14 between the locations 0 and 500 KB. The 3 remaining access bits in the memory 20 corresponding to the segment addresses for locations 0–500 KB are used to provide special control, as mentioned. For instance, for those segments containing only program, only reading of the memory is allowed. This, of course, prevents the inadvertent writing into program. Both reading and writing into the segments which contain data may be permitted. This is indicated to the right of program 59 and data 60 in FIG. 4.

The memory 20 is programmed (i.e., access check bits) to prevent reading of some segments of the main memory except in certain modes (e.g., supervisory mode). This is done, for instance, to prevent a user from reading and then copying an operating system. Referring briefly to FIG. 4, when the program 59 is being run, no access to memory 20 is permitted since such access could cause the relocation base, limit data or access data to be inadvertently altered. Thus, the four access bits provide protection for the program stored within the main memory and also limit access to certain information stored in the memory. In a typical application, an operating system is loaded from a disk into the main memory. Once in the main memory, the CPU can access the operating system in supervisory modes, however, the user is prevented from accessing and hence copying the operating system.

With the present invention, the memory 20 has four times the capacity than is actually needed to provide a relocation base, and limit and access data for the main memory. The signals from the CPU on lines 35 allow the selection of each quadrant of the memory 20. Each of these quadrants are referred to as a context (context 0–3) in the following description.

Referring to FIG. 2, the organization of the MMU memory 20 is illustrated as four separate quadrants: 20*a* (context 0), 20*b* (context 1), 20*c* (context 2) and 20*d* (context 3). Context 1,2 and 3 are each organized in a 256×12 bit arrangement (128×12 bits for the relocation base and 128×12 bits for the limit and access data). Context 0 is selected by the CPU during the supervisory mode and this context stores management data relating to the operating system. It should be noted that each context is capable of storing information covering the entire main memory, thus there are three overlapping MMU memories for user processes.

The value of having these overlapping memories is best illustrated in FIG. 4. The main memory 14 is shown programmed with three processes, P1, P2 and P3. Process 1 is stored between 0 and 500 KB, process 2 between 600 KB and 1 mB and process 3 between 1.2 mB and 1.5 mB. Data relating to the operating system is stored between 1.8 mB and 2 mB. Assume first that the operating system is loaded into memory and is stored between 1.8 mB and 2 mB. An appropriate relocation base is stored within the memory 20 such that during supervisory modes, the addresses 0–200 KB automatically select 1.8 mB through 2 mB in the main memory. Also, the appropriate limits are loaded to assure that during the supervisory mode, the free space in the memory is not accessed. During the supervisory mode (context 0) as indicated in FIG. 4 under the heading context 0, complete access to the MMU memory and main memory is possible (except for access bits which prevent the writing into the operating system stored in main memory thereby protecting the program from damage due to a program error). Since the MMU memory is accessible at this time, it can be programmed through the bus 16 as indicated in FIG. 3, and as previously discussed.

Assume that context 1 is to be used for program 59 and data 60, one quadrant of the MMU's memory 20

corresponding to context 1 is programmed to indicate the location of program 59 and data 60. The limit and access bits are set as indicated under context 1. Thus, when context 1 is selected, program 59 can be read (only) and, reading and writing of data 60 is permitted. No other access to other memory locations is possible nor can the MMU memory be written into.

A second process can be stored in memory. The operating system knows the location of the first process and can program another quadrant of memory 20 for process 2. The relocation base is programmed such that when the CPU addresses locations corresponding to 0–400 KB, locations 600 KB to 1 mB, are provided to the main memory. As indicated under the heading context 2 in FIG. 4, the access bits are programmed to allow reading and writing into the data 50 and reading-only of the program 53. Also, no access (for writing) to the MMU memory is permitted, nor is access permitted to other locations in the main memory. Similarly, a third process can be stored in the main memory for context 4 as indicated in FIG. 4.

The advantage to the arrangement of FIG. 4 is that three separate processes are stored within the main memory and that each process may be easily selected through the MMU's memory, that is, by selecting context 1, 2 or 3. A separate context (context 0) is reserved as a starting point for the operating system, in the presently preferred embodiment, as discussed. This allows running of three separate programs without any reprogramming of the MMU's memory. This versatility is achieved because of the overlapping memory management capacity of the MMU's memory.

Thus, an improved memory management unit has been described which allows a plurality of programs to be run without reprogramming of the computer's MMU memory. The improved unit also limits access to certain types of data and prevents inadvertent writing into programs.

We claim:

1. In a computer system which includes a central processing unit (CPU and a computer main memory, a memory management unit (MMU) coupled to said CPU and said main memory for translating a logical address from said CFU to provide a physical address for accessing said main memory, comprising:

a MMU memory for storing a plurality of relocation base addresses, wherein said relocation base addresses are segmented into sections of memory (contests) such that each said context has at least one relocation base address associated therewith;

each said relocation base address having corresponding limit bits and access bits associated therewith, said limit bits and access bits also store said MMU memory;

said MMU receiving a control signal from said CPU for selecting a predetermined one of said contexts when said logical address is provided by said CPU;

said MMU memory for receiving a first portion of said logical address from said CPU and said first portion of said logical address accessing a stored relocation base address of a selected context and corresponding to said limit and access bits;

an adder coupled to said MMU memory for receiving said accessed relocation base address of said selected context and combining it with a second portion of said logical address to output said physical address for accessing said main memory;

said adder also coupled to receive said limit bits corresponding to said accessed relocation base address and adding it to said second portion of said logical address and generating an indication signal if said second portion of said logical address exceeds a value set by said limit bits;

access check logic means coupled to said MMU memory and said adder for receiving said access bits corresponding to said accessed relocation base address and determining if said access bits permit access of said main memory for a type of access requested by said CPU and generating a fault signal to prevent access of said main memory if an illegal access of said main memory is attempted;

said access check logic means also generating said fault signal if said indication signal is received from said adder;

each said relocation base address for pointing to a corresponding mapped base address in said main memory, such that a given logical address is mapped into a plurality of physical addresses, wherein at least one physical address is provided for each context; and

wherein selected physical addresses of said main memory can be accessed by more than one context.

2. The MMU defined by claim 1 wherein one of said MMU memory contexts is selected as a supervisory context when said CPU is in a supervisory mode, such that said supervisory context accesses all of said main memory.

3. The MMU defined by claim 2 wherein said adder receives said limit number which is a binary complement of an offset from its relocation base address, such that when said binary complement is added to said second portion of said logical address said indication signal is generated when an overflow occurs from said adder.

4. The MMU defined by claim 3 wherein said MMU memory stores said relocation base addresses, said limit bits, and said access bits from said CPU during a MMU program cycle.

5. In a computer system which includes a central processing unit (CPU) and a computer main memory, a memory management unit (MMU) coupled to said CPU and said main memory for translating a logical address from said CFU to provide a physical address for accessing said main memory, an improvement comprising:

a MMU memory for storing a plurality of relocation base addresses, wherein said relocation base addresses are segmented into sections of memory (contexts) such that each said context has at least one relocation base address associated therewith;

each said relocation base address having corresponding limit bits and access bits associated therewith, said limit bits and access bits also stored in said MMU memory;

said MMU receiving a control signal from said CPU for selecting a predetermined one of said contexts when said logical address is provided by said CPU;

said MMU memory for receiving a first portion of said logical address from said CPU and said first portion of said logical address accessing a stored relocation base address of a selected context and corresponding of said limit and access bits;

an adder coupled to said MMU memory for receiving said accessed relocation base address of said selected context and combining it with a second

portion of said logical address to output said physical address for accessing said main memory;

said adder also coupled to receive said limit bits corresponding to said accessed relocation base address and adding it to said second portion of said logical address and generating an indication signal if said second portion of said logical address exceeds a value set by said limit bits;

access check logic means coupled to said MMU memory and said adder for receiving said access bits corresponding to said accessed relocation base address and determining if said access bits permit access of said main memory for a type of access requested by said CPU and generating a fault signal to prevent access of said main memory if an illegal access of said main memory is attempted;

said access check logic means also generating said fault signal if said indication signal is received from said adder;

each said relocation base address for pointing to a corresponding mapped base address in said main memory, such that a given logical address is mapped into a plurality of physical addresses, wherein at least one physical address is provided for each context; and

wherein selected physical address of said main memory can be accessed by more than one context.

* * * * *

Apple Computer Patent

One Button Mouse

United States Patent [19]

Lapson et al.

[11] **Patent Number: 4,464,652**

[45] **Date of Patent: Aug. 7, 1984**

[54] **CURSOR CONTROL DEVICE FOR USE WITH DISPLAY SYSTEMS**

[75] Inventors: **William F. Lapson, Cupertino; William D. Atkinson, Los Gatos, both of Calif.**

[73] Assignee: **Apple Computer, Inc., Cupertino, Calif.**

[21] Appl. No.: **399,704**

[22] Filed: **Jul. 19, 1982**

[51] Int. Cl.³ **G09G 1/00**

[52] U.S. Cl. ..... **340/710**; 340/709; 340/716; 74/471 XY

[58] Field of Search ..... 340/710, 709, 809, 810, 340/870.28, 870.29, 711, 716; 250/231 SE; 74/198, 471 XY; 358/183

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,395,589	8/1968	Gersten	74/198
3,541,541	11/1970	Engelbart	340/710
3,625,083	12/1971	Bosc	74/471 XY
3,835,464	9/1974	Rider	340/710
3,987,685	10/1976	Opocensky	340/710
4,245,244	1/1981	Lijewski et al.	358/183
4,310,839	1/1982	Schwerdt	340/709
4,369,439	1/1983	Brooa	340/710
4,404,865	9/1983	Kim	74/471 XY

FOREIGN PATENT DOCUMENTS

1526428	9/1978	United Kingdom	340/710

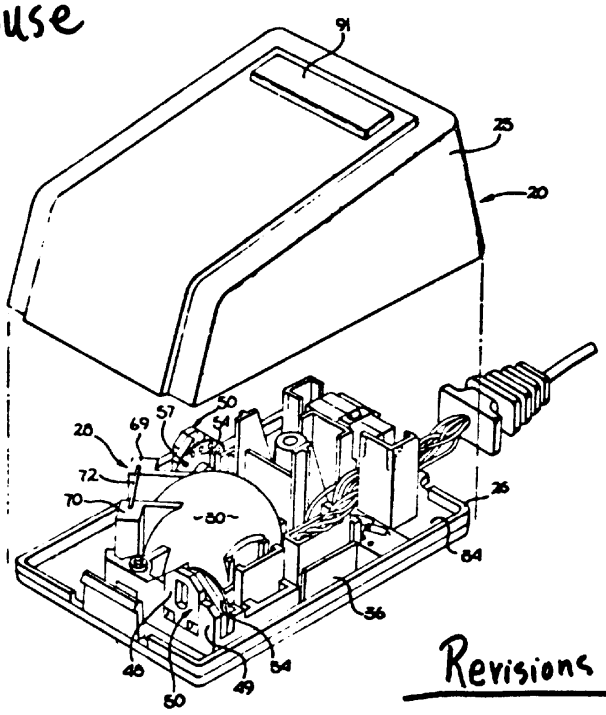
Primary Examiner—Gerald L. Brigance
Attorney, Agent, or Firm—Blakely, Sokoloff, Taylor & Zafman

[57] **ABSTRACT**

A cursor control device having particular application to a computer display system is disclosed. The cursor control includes a unitary frame, having a domed portion substantially surrounding and retaining a ball which is free to rotate. X-Y position indicating means are provided, such that rotation of the ball provides signals indicative of X-Y positions on the display system. The ball is free to "float" in the vertical direction within the dome, and thereby maintain good surface contact. X-Y positions are established by movement of the control device over a surface. A display system and method is disclosed for use in conjunction with the cursor control device, which permits a user to select command options simply by movement of the displayed cursor over a "pull-down" menu bar.

13 Claims, 15 Drawing Figures

Lisa mouse



Revisions

Re. 32,632 29 Mar 1988

Re. 32,633 29 Mar 1988

DAVID T. CRAIG

U.S. Patent Aug. 7, 1984 Sheet 1 of 8 4,464,652

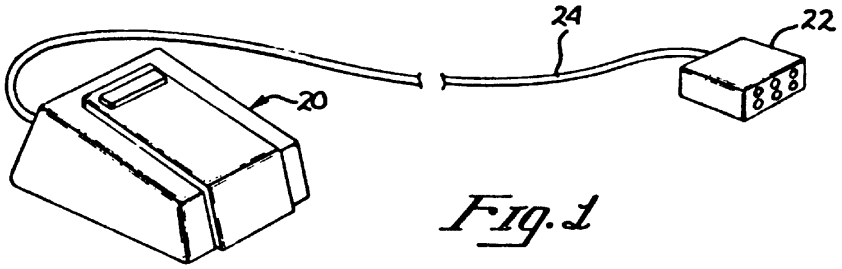


Fig. 1

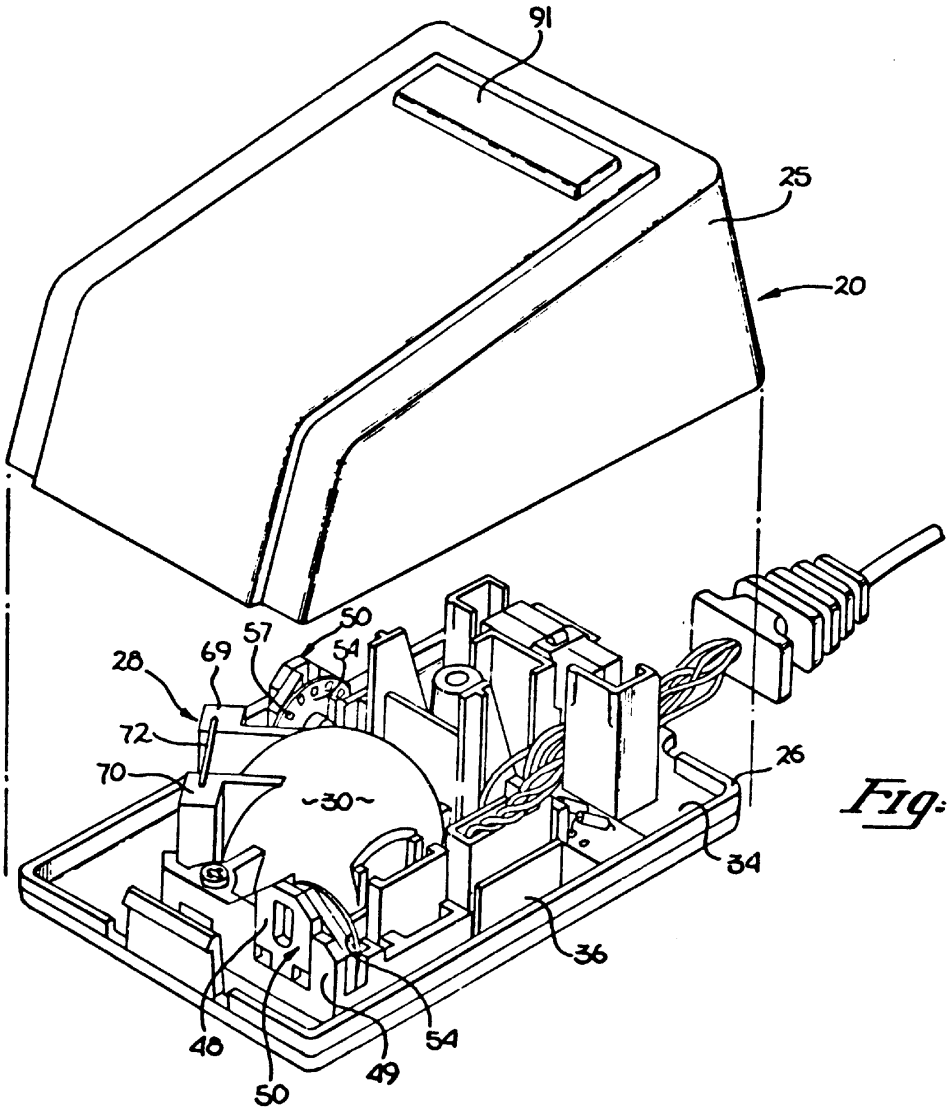


Fig. 2

Fig. 3

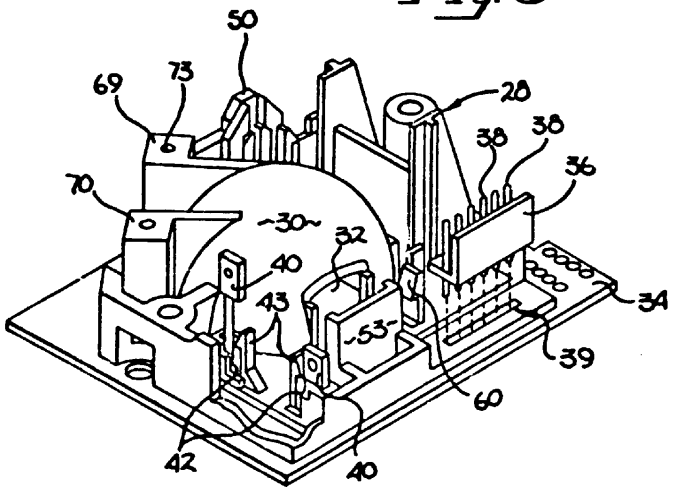
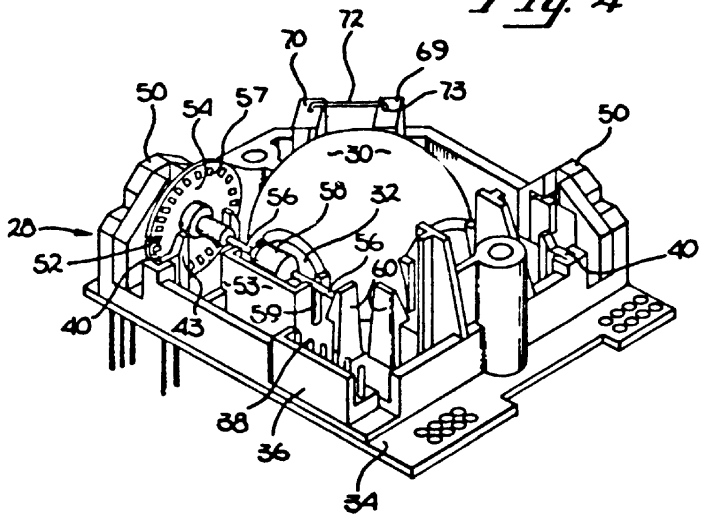


Fig. 4



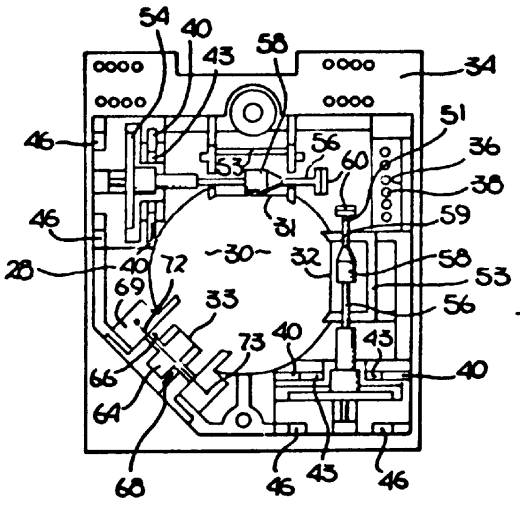


Fig. 5

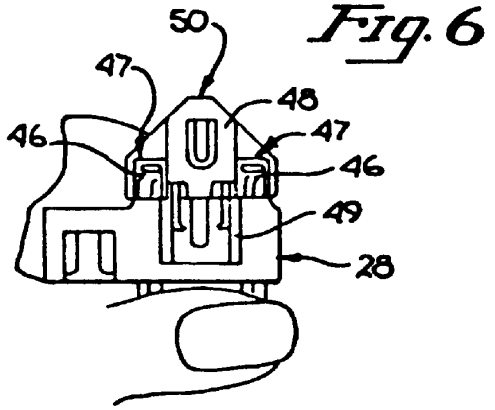


Fig. 6

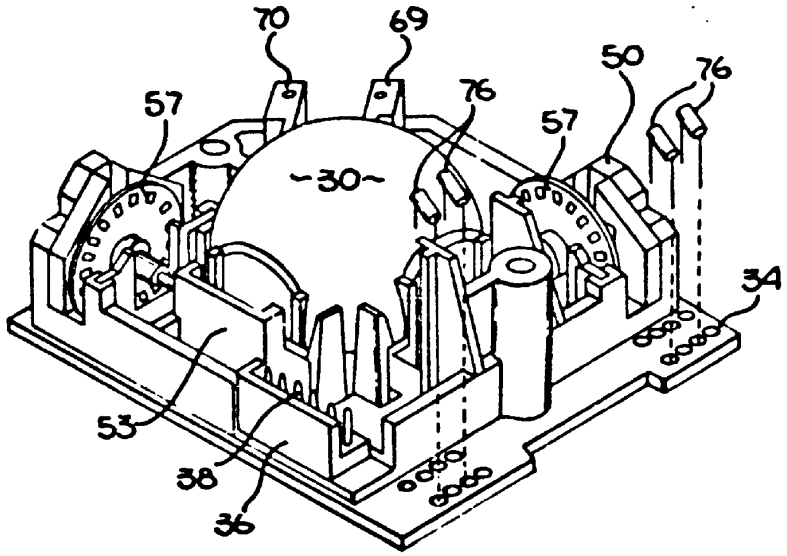


Fig. 7

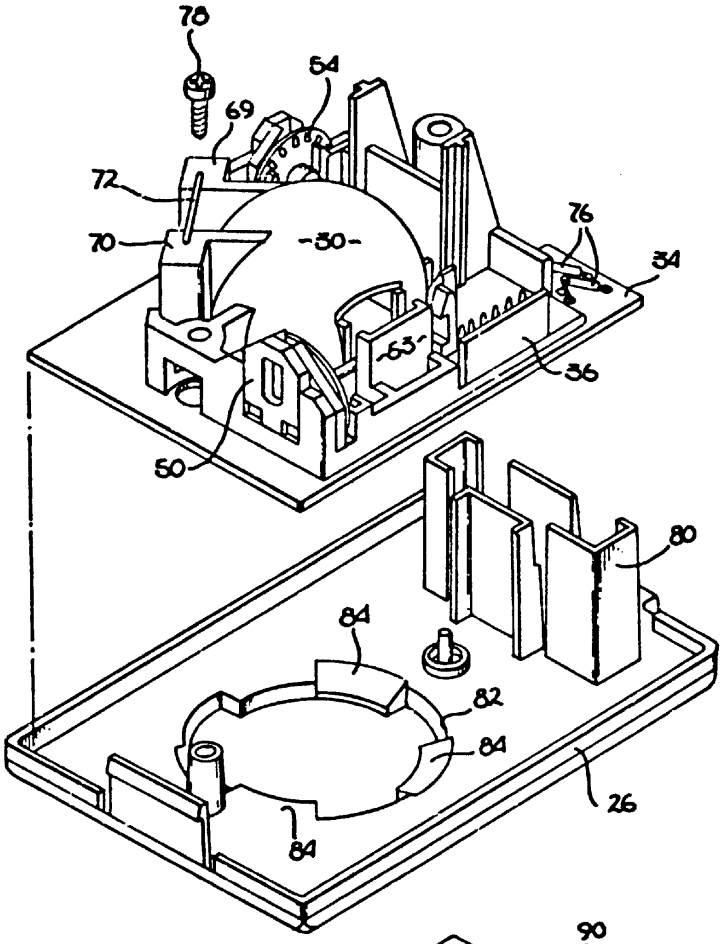

78
54
69
72
70
30
76
34
63
36
50
80
84
82
84
84
26

Fig. 8

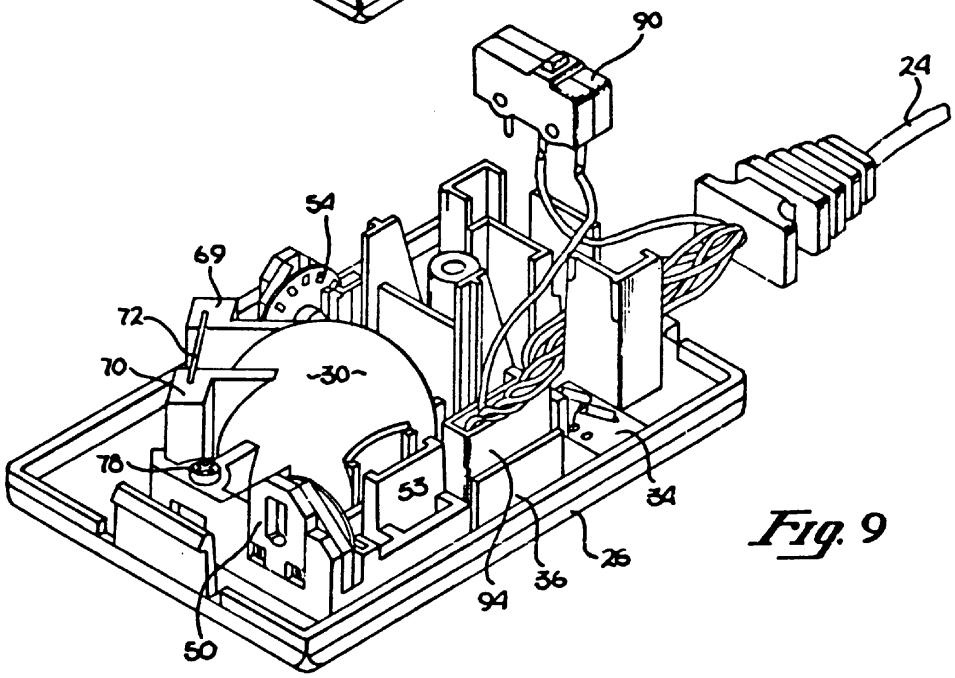

90
24
54
69
72
70
30
78
53
34
26
94
36
50

Fig. 9

U.S. Patent Aug. 7, 1984 Sheet 5 of 8 4,464,652

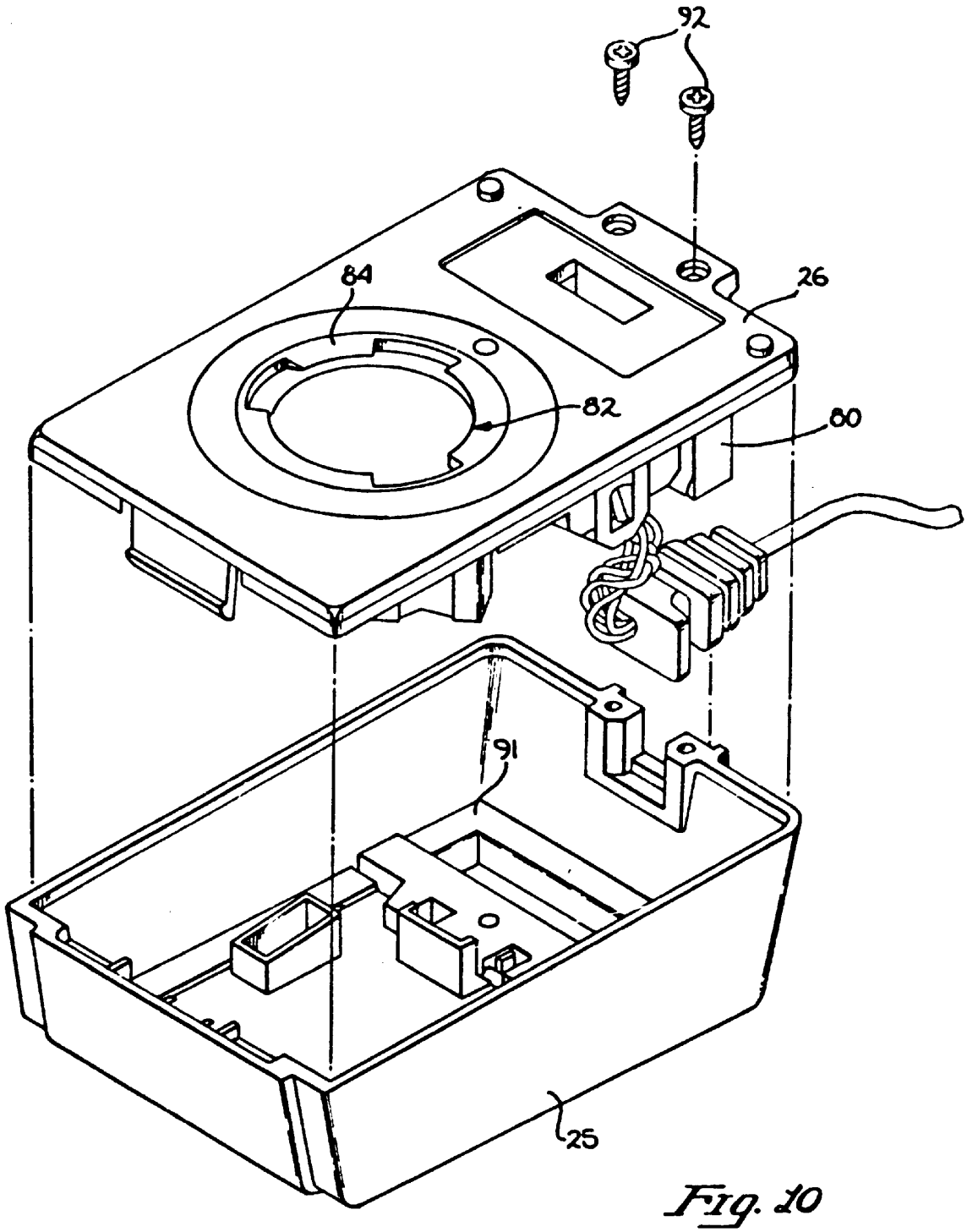


Fig. 10

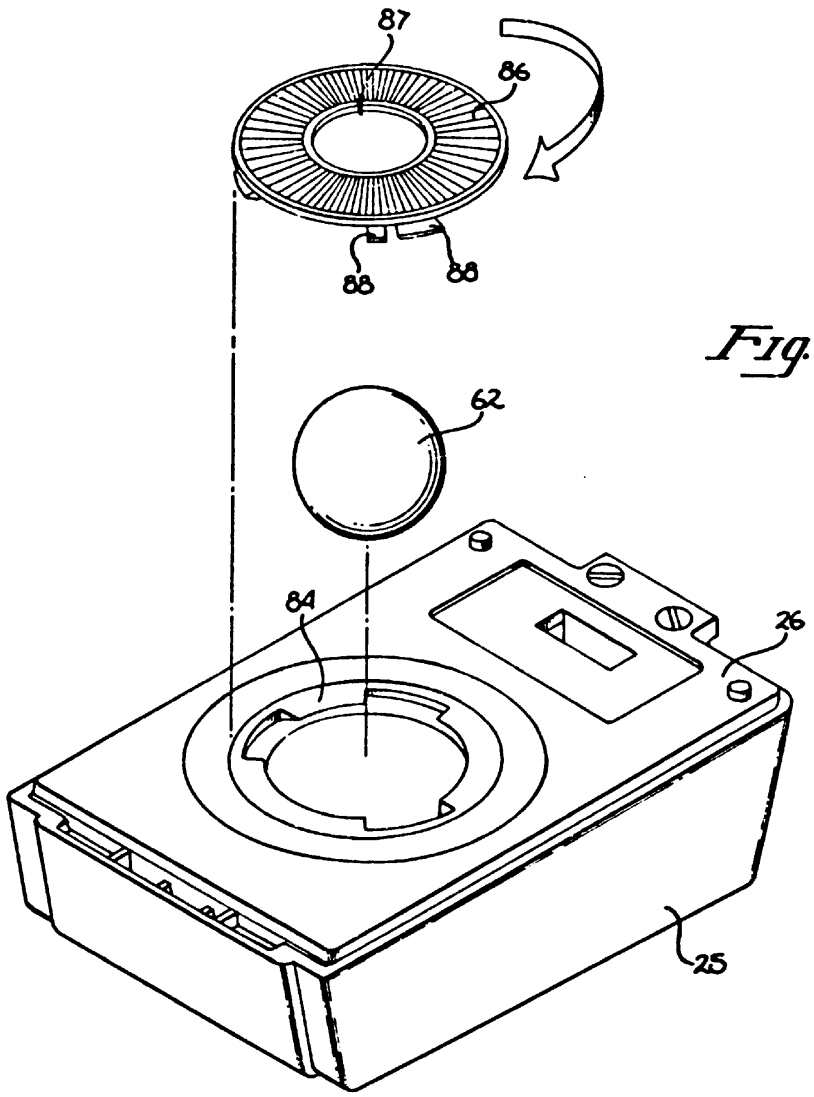


Fig. 11

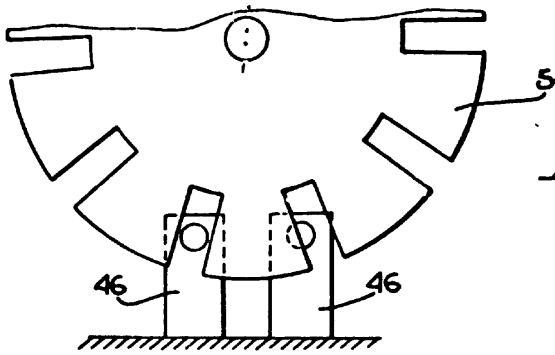


Fig. 12

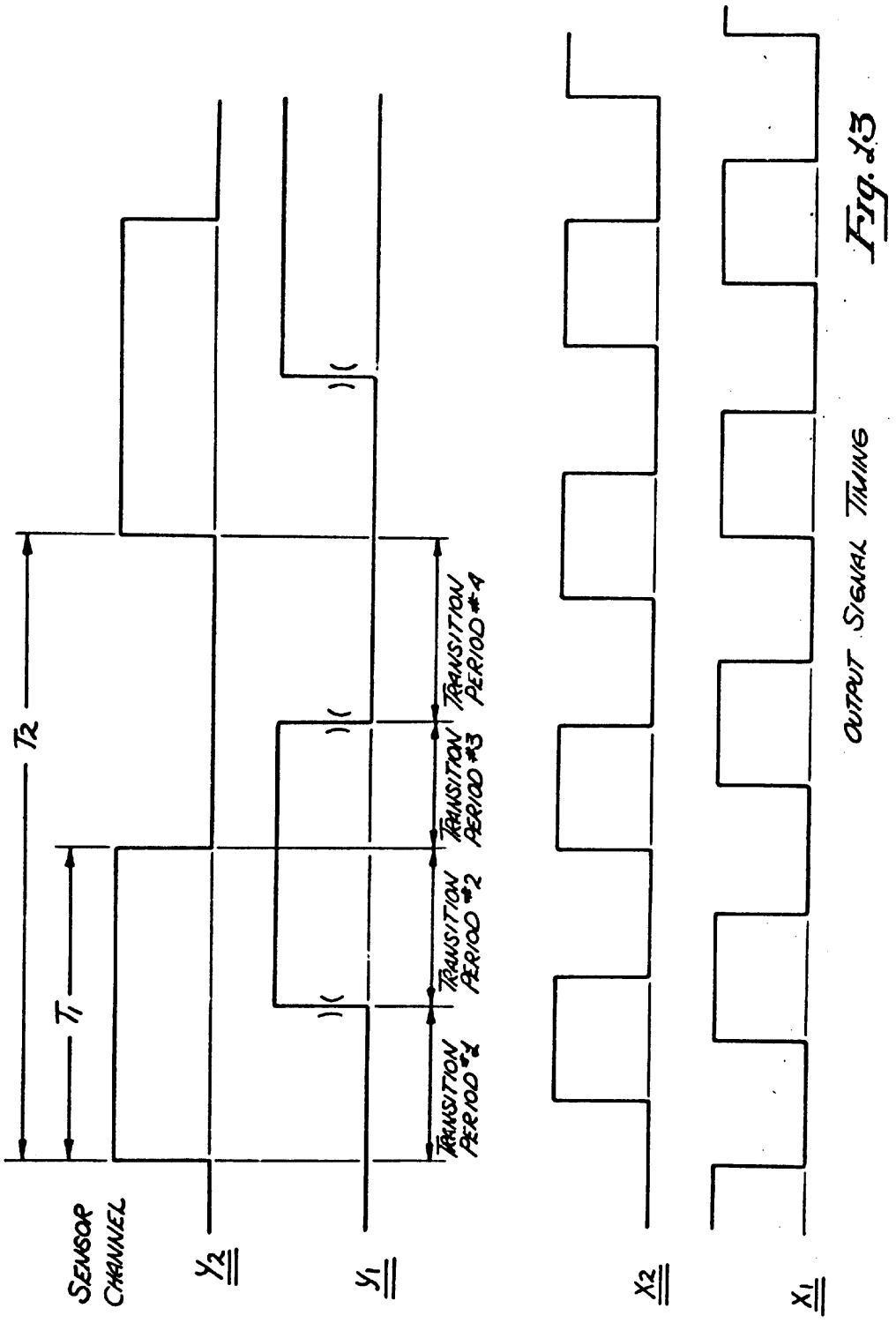

T2
T1
TRANSITION PERIOD #4
TRANSITION PERIOD #3
TRANSITION PERIOD #2
TRANSITION PERIOD #1
SENSOR CHANNEL
Y2
Y1
X2
X1
OUTPUT SIGNAL TIMING

Fig. 13

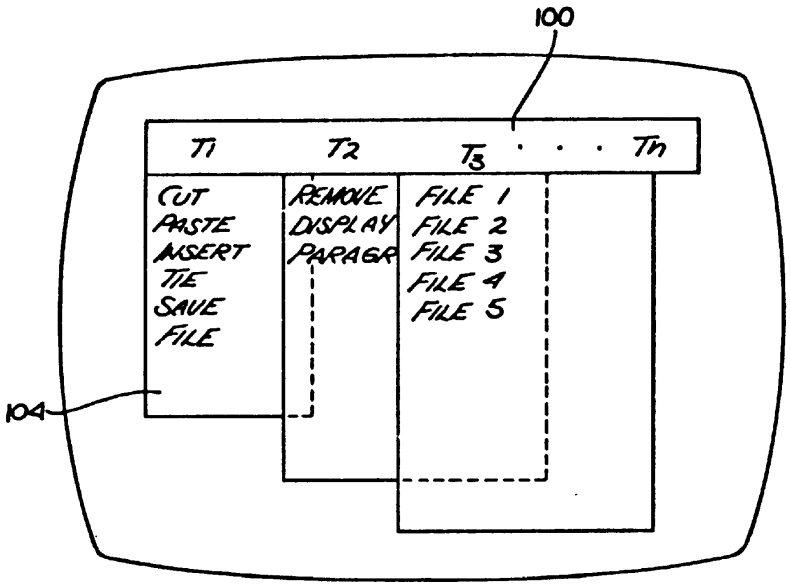

100
T1
T2
T3 . . . Tn
CUT
PASTE
INSERT
TIE
SAVE
FILE
REMOVE
DISPLAY
PARAGR
FILE 1
FILE 2
FILE 3
FILE 4
FILE 5
104

Fig. 14

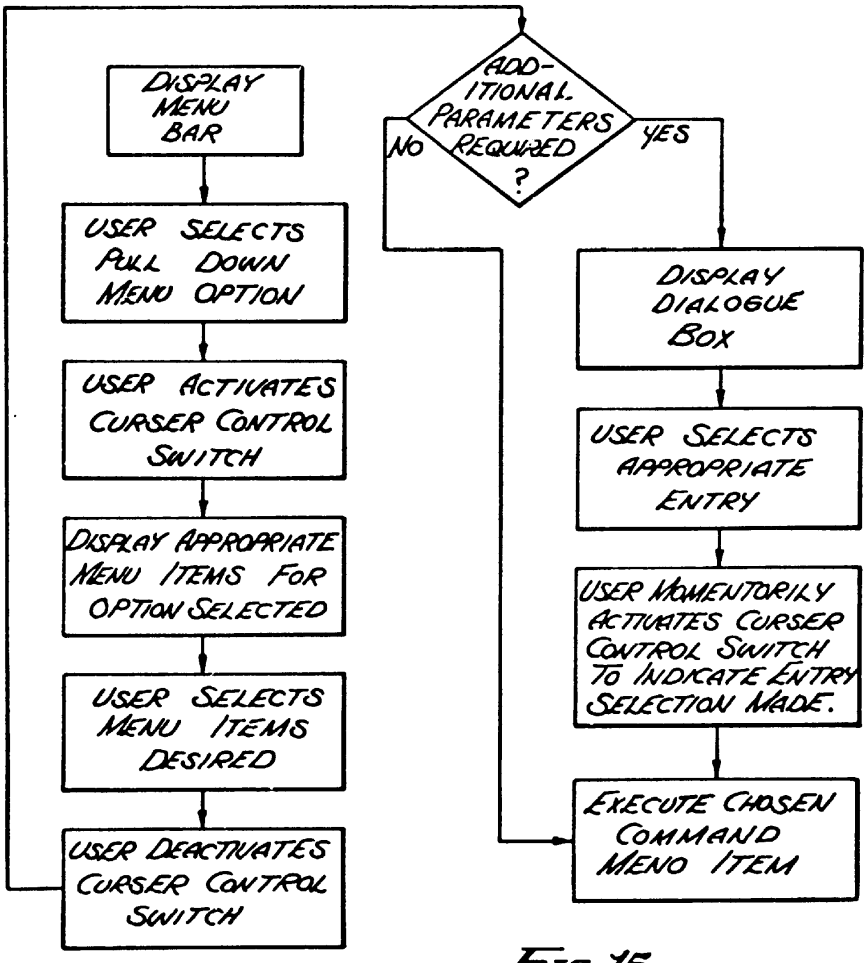

DISPLAY MENU BAR
USER SELECTS PULL DOWN MENU OPTION
USER ACTIVATES CURSER CONTROL SWITCH
DISPLAY APPROPRIATE MENU ITEMS FOR OPTION SELECTED
USER SELECTS MENU ITEMS DESIRED
USER DEACTIVATES CURSER CONTROL SWITCH
ADDITIONAL PARAMETERS REQUIRED ?
NO
YES
DISPLAY DIALOGUE BOX
USER SELECTS APPROPRIATE ENTRY
USER MOMENTORILY ACTIVATES CURSER CONTROL SWITCH TO INDICATE ENTRY SELECTION MADE.
EXECUTE CHOSEN COMMAND MENO ITEM

Fig. 15

CURSOR CONTROL DEVICE FOR USE WITH DISPLAY SYSTEMS

BACKGROUND OF THE INVENTION

1. Field

The present invention relates to the field of display systems, and more particularly to devices which can position a cursor over selected locations on a computer controlled display.

2. Art Background

In many computer controlled display systems, it is desirable to allow the user to control the position of a cursor or the like by means which are external from the main computer keyboard. For example, a user may be required to repetitively choose software options displayed on a cathode ray tube (CRT), or may desire to input data in a diagram format into the computer system. In such situations traditional keyboard input systems are not as effective as a cursor control device commonly referred to as a "mouse".

In a typical "mouse" system, a hand-held transducer provides positional movement signals to the display system. Traditionally, the movement of wheels within the cursor control device are coupled to potentiometers to provide signals indicative of an X-Y position on the display screen (see U.S. Pat. Nos. 3,541,541; 3,269,190; and 3,835,464). Other mouse systems utilize rotating balls on wheels which are in turn coupled to rotate apertures interrupting beams of light, thereby providing positional signals to the display system (see U.S. Pat. Nos. 3,892,963 and 3,541,521).

One common disadvantage of cursor control devices found in the prior art is their cost. Typically, prior art cursor controls include costly mechanical parts which require precise alignment for proper operation. Moreover, it is not uncommon for these devices to exhibit a loss in accuracy over time as the mechanism wears. As computer display capabilities have become more advanced in terms of user real-time graphic interation, cursor control devices have become a necessity in many computer systems. Accordingly, there exists a need to provide a cost effective, simple and highly reliable cursor control device for providing signals indicative of X-Y positions on a computer display system.

As will be disclosed below, the present invention provides an improved cursor control device which overcomes the disadvantages of the prior art by utilizing a unitary frame structure for accurate alignment of all elements and simple assembly, as well as photo-optics to provide the required positional signals. In addition, a display system and method is disclosed for use in association with the cursor control device which permits a user to select command options simply by movement of the cursor over a "pull-down" menu bar.

SUMMARY OF THE INVENTION

A cursor control device having particular application to computer display systems is disclosed. The cursor control includes a unitary frame having a domed portion which houses a ball which is free to rotate. Two encoder disc assemblies are provided, which include roller shafts disposed substantially 90 degrees relative to one another and in contact with the ball. Each roller shaft is coupled to an encoder disc having a plurality of slots disposed radially around the disc periphery. These slots interrupt light beams which are provided by photoemitters and directed at photo-detectors. Each slotted disc interrupts two light beams which are arranged such that when one beam is fully transmitted, the other is partially blocked. Beam interruptions produce signal pulses representing increments of motion, while the order in which the light beams are interrupted indicates the direction of motion, thereby resulting in an X-Y position on a display system. The ball is maintained in contact with the roller shafts by a spring biased idler wheel. The ball is free to "float" in the vertical direction within the dome, and thereby maintain good surface contact. Moreover, the ball may be easily removed for cleaning to insure that any build up of lint or the like does not prevent the ball from rotating smoothly. A switch is provided within the cursor control housing in order to signal the display system that a desired X-Y location on the display screen has been selected. In operation, a user may selectively position a cursor or the like on a display system by simply moving the cursor control device over a surface, such as a desk, until the desired cursor position is shown on the display device. A display system and method is disclosed for use in conjunction with the cursor control device, which permits user to select command options simply by movement of the displayed cursor over a "menu bar".

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the present invention.

FIG. 2 is a perspective of the present invention illustrating the cursor control device as it appears without the housing cover.

FIG. 3 is a perspective view of the unitary frame of the present invention coupled to the printed circuit board base, illustrating the placement of photo-detectors and the coupling connector.

FIG. 4 is a further perspective view of the unitary frame and circuit board of FIG. 3 illustrating the position of a roller shaft and encoder wheel.

FIG. 5 is a top view of the unitary frame and printed circuit board of the present invention.

FIG. 6 is a partial view of the unitary frame in FIG. 3, illustrating the insertion of a detector aperture.

FIG. 7 is a perspective view of the unitary frame of FIG. 3, illustrating the placement of resistors on the printed circuit board.

FIG. 8 is a perspective view of the coupling of the unitary frame cage and printed circuit board combination to the housing base of the present invention.

FIG. 9 is a perspective view illustrating the placement of the control switch within the housing base.

FIG. 10 is the perspective view of the final assembly of the present invention illustrating the coupling of the cover and base portions of the housing.

FIG. 11 is a perspective view illustrating the insertion or removal of the floating and rotating ball.

FIG. 12 is a diagrammatical illustration of the alignment of the photo-emitters in relation to each encoder disc.

FIG. 13 is a diagrammatical illustration of a sample quadrature output of the present invention indicative of X-Y locations on a display system.

FIG. 14 is a diagrammatical illustration of a "pull down" menu bar display.

FIG. 15 is a block diagram illustrating the sequence of steps utilized by the present invention to display options and associated commands on a "pull-down" menu bar display.

DETAILED DESCRIPTION OF THE INVENTION

A cursor control device having particular application for use in conjunction with a computer display system is disclosed. In the following description for purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced without the specific details. In other instances, well known systems are shown in diagrammatical or block diagram form in order not to obscure the present invention unnecessarily.

Referring now to FIG. 1, the present invention includes a hand held cursor control unit 20 which is coupled to a plug 22 by means of a cable 24. As best illustrated in FIG. 2, cursor control unit 20 includes a cover 25 and a base 26 upon which the internal workings of the present invention are disposed. As will be apparent from the discussion which follows, cursor control unit 20 is designed with ease of assembly in mind, while providing very close tolerances and high X-Y position location accuracy.

With reference to FIGS. 3, 4 and 5, a premolded unitary frame 28 is provided which includes a domed housing 30 presently having three cut-out locations 31, 32 and 33. As illustrated, cut-outs 31 and 32 are disposed substantially at 90 degrees with respect to one another, with cut-out 33 being oriented generally symmetrically opposite the other cut-outs. In addition, frame 28 includes a plurality of bosses, slots and shaped stems of material which when pertinent will be discussed in this specification. In the presently preferred embodiment, the frame 28 is comprised of a plastic material (e.g. polycarbonate) which is impregnated with a lubricant (e.g. teflon). Thus, during operation and throughout its useful life, cursor control unit 20 does not require the addition of either wet or dry lubricants. Frame 28 is mounted on a printed circuit board 34 to facilitate electrical connection between the various electrical elements within the unit. Electrical connector header 36 is mounted as shown (see FIG. 3) to the unitary frame 28 such that connector pins 38 pass through a rectangular slot 39 through the frame to the circuit board below. As will be discussed, cable 24 is electrically coupled to the cursor control unit 20 through connector 36.

As illustrated in FIG. 3, photo-emitters 40 are inserted into slots 42 such that the emitter portion is facing away from the dome 30 (note that one emitter 40 is shown in FIG. 3 partially inserted). Upwardly extending clips 43 are snapped over portions of each emitter 40, as shown, to prevent them from being dislodged. Similarly, two photo-detectors 46 are inserted facing the emitters 40 into slots 47 in each of two detector apertures 50. As shown in FIG. 6, an outwardly extending portion 48 of each detector aperture 50 is aligned with guides 49 formed integrally with the frame 28, and the aperture is then snapped downward into place. Thus, each detector aperture 50 houses two detectors 46 which face two emitters 40, respectively. In the presently preferred embodiment, the emitter/detector combination operates within the infrared region. However, it will be appreciated that any suitable wavelength may be used in a particular application. In addition, presently, the detectors 46 incorporate integral Schmitt triggers to provide detector outputs which more closely approximate a digital signal.

Two encoder disc assemblies are provided to convert, as will be described, the movement of the cursor control unit 20 into signals indicative of X-Y locations defined on the display system. Each encoder assembly 52 includes an encoder disc 54 axially coupled to a roller shaft 56. In addition, each encoder disc 54 is provided with a plurality of radially disposed slots 57 which interrupt the light beams generated by the photo-emitters 40. A cylindrical contact member 58 surrounds each roller shaft 56 at each respective cut out location, as illustrated. Each encoder disc assembly 52 is mounted on the unitary frame 28 by inserting the encoder disc 54 between the detector aperture 50 and emitters 40 and snapping an end clip 60 over the opposite end of the roller shaft 56 (See FIGS. 4, 5 and 7), thereby allowing rotation of the roller shaft and encoder disc with a minimum of friction. As illustrated, each shaft 56 is slipped into and carried by a "U" shaped guide 59 formed from upwardly extending alignment bosses 53 to maintain each roller shaft 56 in proper orientation. End 51 of the shaft 56 is carried for rotation within a hollow portion of the detector aperture 50, such that encoder disc 54 is disposed in close proximity to the aperture 50. The present invention's use of integral lubrication within the frame material, permits each shaft 56 to freely rotate about its longitudinal axis.

As a result of the above described configuration, the radially disposed slots 57 of each encoder disc interrupt two light beams from photo-emitters 40. The position of the emitter/detector combination and encoder disc is such that when one beam is fully transmitted, the other is partially blocked by a slit on the encoder disc. As will be discussed, in operation a ball 62 is disposed within the dome 30 of the frame, and retained such that it is maintained in contact with both cylindrical contact members 58. The rotation of the ball 62 within the dome 30 in turn causes the rotation of each roller shaft 56 and its respective encoder disc. As will be discussed, the beam interruptions from the rotation of each encoder disc 54 produce signal pulses representing increments of motion, while the order in which the light beams are interrupted indicates the direction of motion of the cursor control unit.

Ball 62 is retained against the cylindrical contact members 58 by an idler wheel 64 mounted for rotation on a fixed shaft 66, as best shown in FIG. 5. The idler wheel 64 and shaft 66 are inserted within a slot 68 formed by rectangular bosses 69 and 70 extending upwardly from the frame's base. Wheel 64 extends through cut-out 33 into the interior of the dome 30. The legs of a staple shaped idler spring 72 are inserted through passages 73 passing perpendicular to the horizontal plane of the frame 28 and circuit board 34, thereby retaining the shaft 66 within the slot 68.

Referring now to FIG. 7, resistors 76, which are required by the specific electronics of the emitter/detector combination of the present invention, are inserted into the printed circuit board 34. The resistors 76 and associated leads from the connector 36, photo-emitters 40, and photo-detectors 46 are then electrically connected and soldered in place as is conventionally done in the art.

With reference now to FIGS. 8, 9 and 10, the assembled frame 28 and circuit assembly is mounted on the base 26 by means of a screw 78. As illustrated, base 26 includes an upwardly extending switch retaining portion 80 and a generally circular cut-out orifice 82. As best shown in FIGS. 8, 10 and 11, circular orifice 82 is

disposed substantially below the opening of dome 30, and includes outwardly extending locking ridges 84 which are designed to accommodate a lock cap 86 (See FIG. 11), such that ball 62 may be retained within the dome 30. Lock cap 86 includes outwardly extending tabs 88 arranged to interleaf with ridges 84. In operation, a user desiring to insert or remove ball 62 from the cursor control unit 20, may unlock and remove the lock cap 86 from the orifice 82 by simply rotating the cap such that the tabs 88 and ridges 84 no longer interleaf.

As illustrated, lock cap 86 generally has a toroidal form having a central orifice 87 of smaller diameter than cutout orifice 82. It will be apparent, that once ball 62 is inserted and retained by lock cap 86, Thus, ball 62 contacts the surface below the cursor control unit 20 and rotates in response to the movement of the unit on the surface.

As shown in FIG. 9, cable 24 is coupled to cursor control 20 through a female connector 94 which is inserted over pins 38. A switch 90 is coupled to the cable 24 through electrical connector 36, and is inserted within the retaining portion 80. A switch cap 91 forms part of the cover 25 (see FIG. 1), and is disposed above switch 90 such that the depression of the switch cap 91 forces switch 90 to electrically close, and thereby signal the computer display system that an appropriate X-Y location has been selected. As shown in FIG. 10, base 26 and cover 25 are coupled by securing both sections to one another using screws 92. Once the cover and base have been joined, ball 62 is inserted and lock cap 86 is attached as discussed above to retain the ball within the dome portion 30.

With reference to FIGS. 12 and 13, a sample quadrature output of the cursor control unit 20 is illustrated. As previously described, photo-detectors 46 are disposed such that if one detector is fully exposed by a slot of the encoder disc 54, the other detector is only partially exposed. Thus, in addition to the increments of motion of the cursor control over a surface, the direction of motion may also be determined. Assume for sake of example that the cursor control 20 is moved. As illustrated in FIG. 13, a substantially digital output signal is generated by each photo-emitter/detector combination associated with each encoder assembly. In the example shown, cursor control 20 would provide a regularly spaced output from the X channel detectors if the control 20 is moved over a surface at a constant speed along the X-axis. Similarly, if there is little movement of the control unit along the Y axis, little change will occur on the Y channels inasmuch as the Y encoder disk is not being rotated significantly (see FIG. 13). The computer display system is provided with appropriate software or hardware, for example edge detectors, to detect signal state transitions. Thus, the signals from each pair of channels may be decoded such that the X-Y direction of motion may be determined for the particular order of transition changes from each channel along an axis. Inasmuch as the particular circuitry and software used for decoding the various signals and positioning the cursor or the like on a display system will be apparent to one skilled in the art, the details of such will not be recited herein.

Referring now to FIGS. 14 and 15, a display system and method for use in conjunction with the cursor control device 20 will be described. As previously discussed, control 20 is coupled to a display system which is controlled by a computer or other equivalent circuitry. Appropriate programming of the computer is provided such that a "menu" bar 100 comprising a variety of command options indicated by titles (for example, T_1, T_2, T_3 . . . T_n), is displayed across the CRT screen or the like as shown in FIG. 14. If a particular title (for example T_1) is selected, one or more sub-command items 104 are displayed by the computer system below the primary menu title. As illustrated, the sub-command items appear to the user to be "pulled down" from the main menu bar 100. The user then selects a desired item for execution by the computer by appropriate movement of a cursor control, as will be described. Although the list of items 104 are shown for illustration below menu title options T_1, T_2, and T_3, in the present embodiment only one menu option may be pulled down and displayed at a time.

The sequence of operations executed by the computer system to permit the user to select a particular menu title and subcommand item is shown in FIG. 15. The computer initially displays menu bar 100 on the display system as shown in FIG. 14. A user desiring to select a particular title moves cursor control unit 20 over a surface, thereby rotating ball 62 within dome 30 and sending signals indicative of X-Y locations to the display system for corresponding movement of a cursor or the like on the display screen. Once the cursor is positioned over (or in proximity with) the chosen menu title selection, the user depresses switch cap 91 on cursor control 20, thereby activating switch 90, and signaling the computer system that the particular title has been selected. The computer display system then either executes the menu title if it is an immediate command, or displays a set of sub-command items for user selection. If items are displayed, the user continues to depress switch cap 91, and once again moves the cursor control over the surface until the displayed cursor lies over or in proximity with the item to be executed. The user then removes pressure from the switch cap 91 thereby deactivating switch 90, and indicating to the computer which item is to be executed.

The computer system then determines if further parameters are required to be specified by the user. If no further data is required, the computer executes the item indicated by the cursor position on the display screen. However, if parameters must be specified by the user prior to execution a "dialogue box" is defined on the display system which displays the various data selections which are required. For example, a user may be required to select page formats, specify numerical values, etc. In the present embodiment, a user inputs the desired data selections by positioning the cursor over the selection, in for example a multiple choice format, and momentarily activates the switch 90 on the cursor control unit. Once the required selections are made, the computer proceeds to execute the chosen menu item.

Accordingly, it is possible for a user to select and execute a variety of commands without the necessity of inputting characters on a keyboard, as is commonly required in the art. Rather, the present invention permits fast entry and execution of commands, such as for example in a word processing system or the like, wherein large blocks of text or other data may be manipulated or operated upon simply by movement of the cursor control 20 over a surface and the appropriate depression of switch 90.

Thus, an improved cursor control and display system has been described. The present invention permits a user to select desired menu titles on a menu bar by movement of a cursor control over a surface. Sub-com-

mand items may be specified for execution by the computer control display system in the same manner, such that the operator need not enter command characters on a keyboard or the like in order to access and execute most system functions.

Although the present invention has been described with reference to FIGS. 1–15 and with emphasis on a "pull down" type display system, it should be understood that the figures are for illustration only and should not be taken as limitations upon the invention. It is contemplated that many changes and modifications may be made, by one of ordinary skill in the art, to the materials and arrangements of the elements of the invention without department from the spirit and scope of the invention as disclosed above.

What is claimed is:

1. A device for providing signals indicative of X-Y locations on a display system or the like, comprising:

a housing including a base having an opening for the passage of a rotatable ball;

a unitary frame disposed on said base including:

a domed portion integrally formed with said frame substantially surrounding and retaining said rotatable ball;

said domed portion having first and second cut-outs through said dome disposed substantially at 90 degrees with respect to one another, and a third cut-out disposed at an angle with respect to said first and second cut-outs;

X-Y position indicating means passing through said first and second cut-outs, for converting the rotation of said ball into signals indicative of X-Y positions on said display system;

biasing means passing through said third cut-out, for biasing said ball against said X-Y position indicating means;

means for removing said ball from said domed portion through said opening in said base, such that said ball and the interior or said dome may be serviced, said means for removing comprising:

outwardly extending lock ridges integrally formed with said opening in said base;

a lock cap having a second opening of smaller diameter then said base opening to permit only a portion of said ball to pass therethrough and contact said surface;

said lock cap further including outwardly extending lock tabs to interleaf with said lock ridges, such that rotation of said cap interleafs with said tabs and ridges thereby locking said cap onto said base;

whereby movement of said device over a surface such that a portion of said ball is maintained in contact with said surface results in X-Y positions defined on said display system.

2. The device as defined by claim 1, wherein said biasing means comprises a wheel carried by a shaft, said shaft being biased such that said wheel is maintained in contact with said ball.

3. The device as defined by claim 2, wherein said third cut-out is disposed generally at 45 degrees with respect to said first and second cut-outs.

4. The device as defined by claim 3, wherein said X-Y position indicating means includes a roller shaft coupled to an encoder disc having a plurality of radially disposed slots, said disc being disposed between a photo-emitter and photo-detector.

5. The device as defined by claim 4, wherein said photo-detector is disposed within a detector aperture, said aperture being retained on said unitary frame to form an integral unit.

6. The device as defined by claim 5, further including a circuit board disposed between said frame and said base.

7. The device as defined by claim 6, further including a switch coupled to said circuit board to specify selected X-Y positions on said display system.

8. The device as defined by claim 7, said device being coupled to a computer controlled display system wherein menu commands are displayed and selected by a user through movement of said device.

9. A computer controlled display system having a display wherein a plurality of command options are displayed along a menu bar and sub-command items corresponding to each option are displayed once said option has been selected, comprising:

first display means coupled to said computer for gensrating and displaying said menu bar comprising said plurality of command options;

cursor control means coupled to said display system for selectively positioning a cursor on said display, said cursor control means including a cursor control device for movement over a surface, the movement of said cursor control device over said surface by a user resulting in a corresponding movement of said cursor on said display;

signal generation means including a switch having a first and second position coupled to said display system for signalling said computer of an option choice once said cursor is positioned over a first predetermined area on said display corresponding to an option to be selected, said user placing said switch in said second position while moving said cursor control device over said surface such that said cursor is over said first predetermined area;

second display means coupled to said computer for generating and displaying said sub-command items corresponding to said selected option;

said switch being placed in said first position by said user once said user has positioned said cursor over a second predetermined area corresponding to a sub-command item to be selected;

whereby an option and a sub-command item is selected and executed by said computer.

10. The display system of claim 9 wherein said cursor control device comprises:

a housing including a base having an opening for the passage of a rotatable ball;

a unitary frame disposed on said base including:

a domed portion integrally formed with said frame substantially surrounding and retaining said rotatable ball;

said domed portion having first and second cut-outs through said dome disposed substantially at 90 degrees with respect to one another, and a third cut-out disposed at an angle with respect to said first and second cut-outs;

X-Y position indicating means passing through said first and second cut-outs, for converting the rotation of said ball into signals indicative of X-Y positions on said display system;

biasing means passing through said third cut-out, for biasing said ball against said X-Y position indicating means;

means for removing said ball from said domed portion through said opening in said base, such that said ball and the interior of said dome may be serviced, said means for removing said ball comprising:

outwardly extending lock ridges integrally formed with said opening in said base;

a lock cap having a second opening of smaller diameter then said base opening to permit only a portion of said ball to pass therethrough and contact said surface;

said lock cap further including outwardly extending lock tabs to interleaf with said lock ridges, such that rotation of said cap interleafs with said tabs and ridges thereby locking said cap onto said base;

whereby said option and sub-command item may be selected by movement of said cursor control means over a surface such that a portion of said ball is in contact with said surface.

11. In a computer controlled display system having a display wherein a plurality of command options are displayed along a menu bar and sub-command items corresponding to each option are displayed once said option has been selected, a method for selecting an option and an item, comprising the steps of:

(a) generating and displaying said menu bar comprising said plurality of command options;

(b) positioning a cursor on said display using a cursor control device for movement over a surface, the movement of said cursor control device over said surface by a user resulting in a corresponding movement of said cursor on said display;

(c) signalling said computer of an option choice once said cursor is positioned over a first predetermined area on said display corresponding to an option to be selected, said user signalling said computer by placing a switch coupled to said display system in a second position while moving said cursor control device over said surface such that said cursor is over said first predetermined area;

(d) generating and displaying said sub-command items corresponding to said selected option;

(e) positioning said cursor over a second predetermined area corresponding to a sub-command item to be selected, said switch being maintained in said second position until said cursor is positioned over said second predetermined area;

(f) placing said switch in a first position once said user has positioned said cursor over said second predetermined area;

whereby an option and an item associated with said option is selected.

12. The method as defined by claim 11, wherein said switch is disposed on said cursor control device.

13. The method as defined by claim 12, where said computer displays said sub-command items generally below said optiion on said menu bar.

* * * * *

Apple Computer Patent

Twiggy
Floppy Disk Drive

United States Patent [19]

Jordan et al.

[11] **Patent Number: 4,466,033**

[45] **Date of Patent: Aug. 14, 1984**

[54] **DISK DRIVE WITH AUTOMATIC DISC CLAMPING AND EJECTING**

[75] Inventors: **Richard Jordan**, Los Altos; **William Bull**, Sunnyvale; **Robert L. Ciardella**, Saratoga; **Robert Taggart**, Portola Valley; **Frederick R. Holt**, Cupertino, all of Calif.

[73] Assignee: **Apple Computer, Inc.**, Cupertino, Calif.

[21] Appl. No.: **351,652**

[22] Filed: **Feb. 24, 1982**

[51] **Int. Cl.**³ **G11B 17/02; G11B 5/016**
[52] **U.S. Cl.** **360/99**
[58] **Field of Search** 360/97, 98, 99, 106

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,193,102	3/1980	Beuch	360/99
4,359,762	11/1982	Stollorz	360/98

FOREIGN PATENT DOCUMENTS

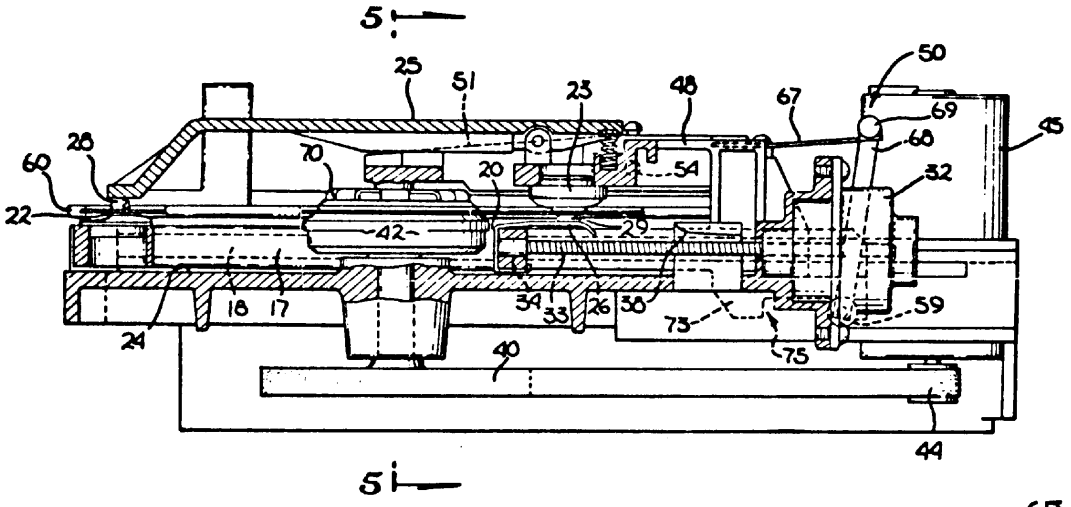
0010172	4/1980	European Pat. Off. .
0042061	12/1981	European Pat. Off. .
1466809	3/1977	United Kingdom .
2016794	8/1982	United Kingdom .

Primary Examiner—Bernard Konick
Assistant Examiner—Paul Stefanski
Attorney, Agent, or Firm—Blakely, Sokoloff, Taylor & Zafman

[57] **ABSTRACT**

A floppy disk drive with automatic disc clamping and ejection is disclosed. The movement of the linear actuator is used to provide both the clamping and ejection, without other drive means. A pair of magnetic heads, positioned on opposing sides of a drive wheel, are fixed to a carriage, one engages the upper surface of the disc, the other the lower surface. Neither head moves relative to the other. The drive components are easily assembled providing a relatively inexpensive, yet reliable drive.

9 Claims, 12 Drawing Figures



Lisa "Twiggy" drive
(5.25" disks, 860K)

DAVID T. CRAIG

U.S. Patent Aug. 14, 1984 Sheet 1 of 6 4,466,033

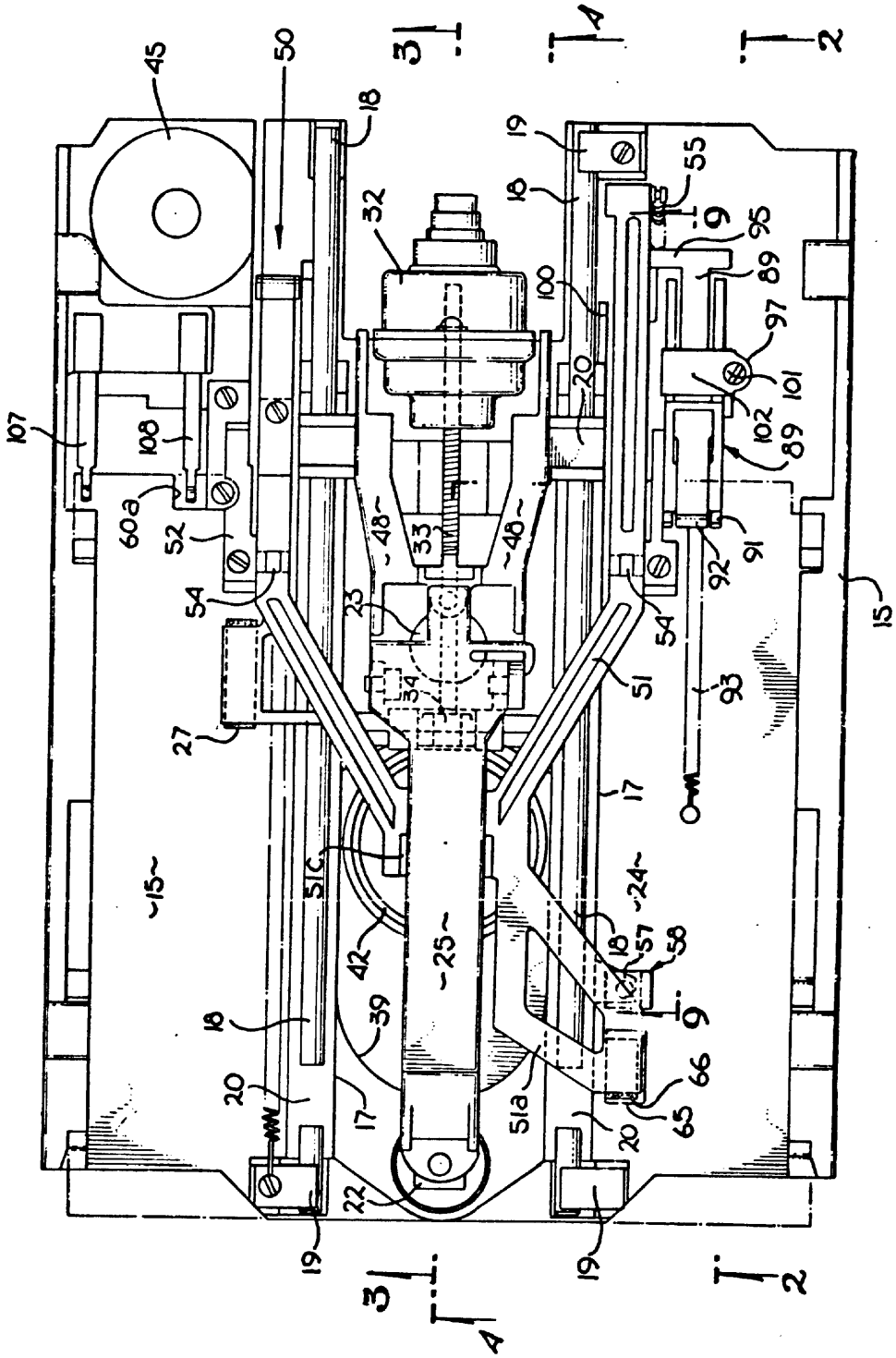


Fig. 1

U.S. Patent Aug. 14, 1984 Sheet 2 of 6 4,466,033

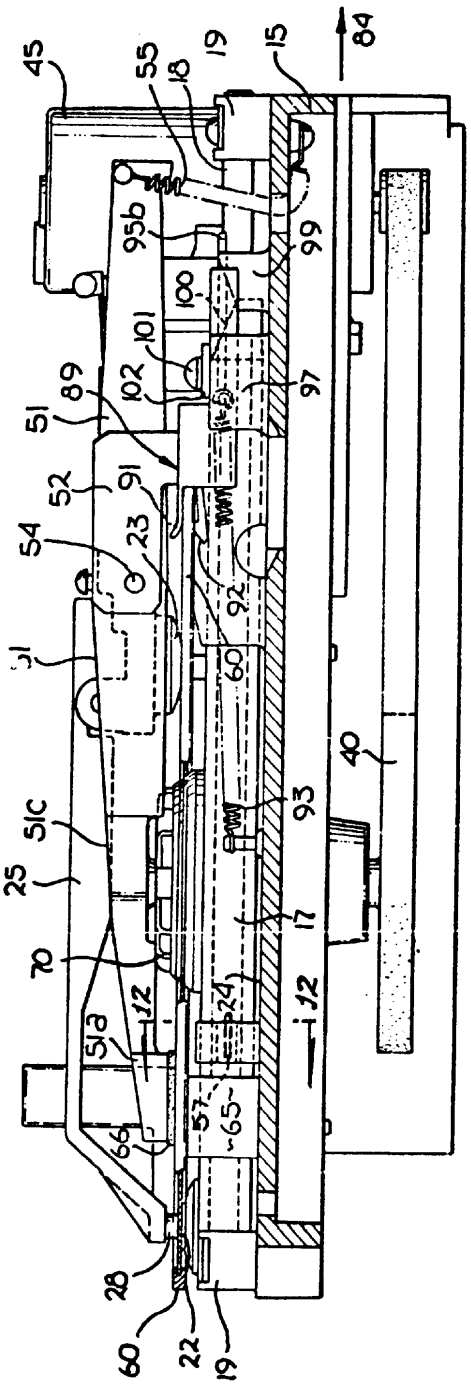


Fig. 2

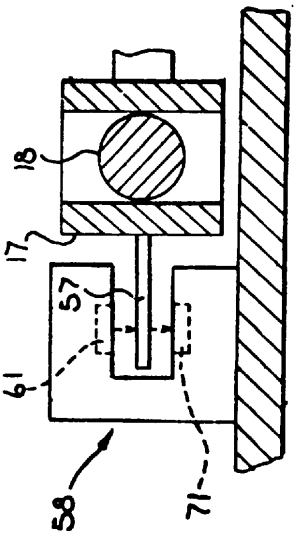


Fig. 12

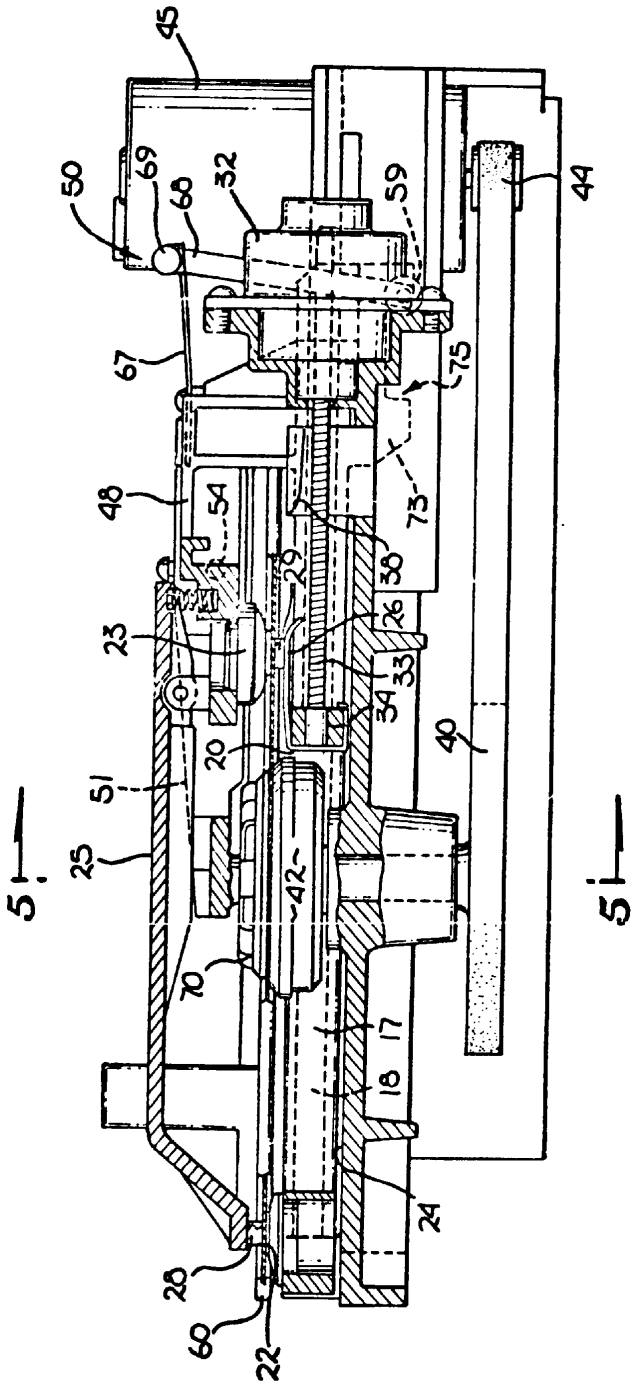

45
50
69
68
32
59
44
67
75
48
54
73
29
30
26
23
33
34
40
20
51
25
42
70
17
18
24
28
60
22
5
5

Fig. 3

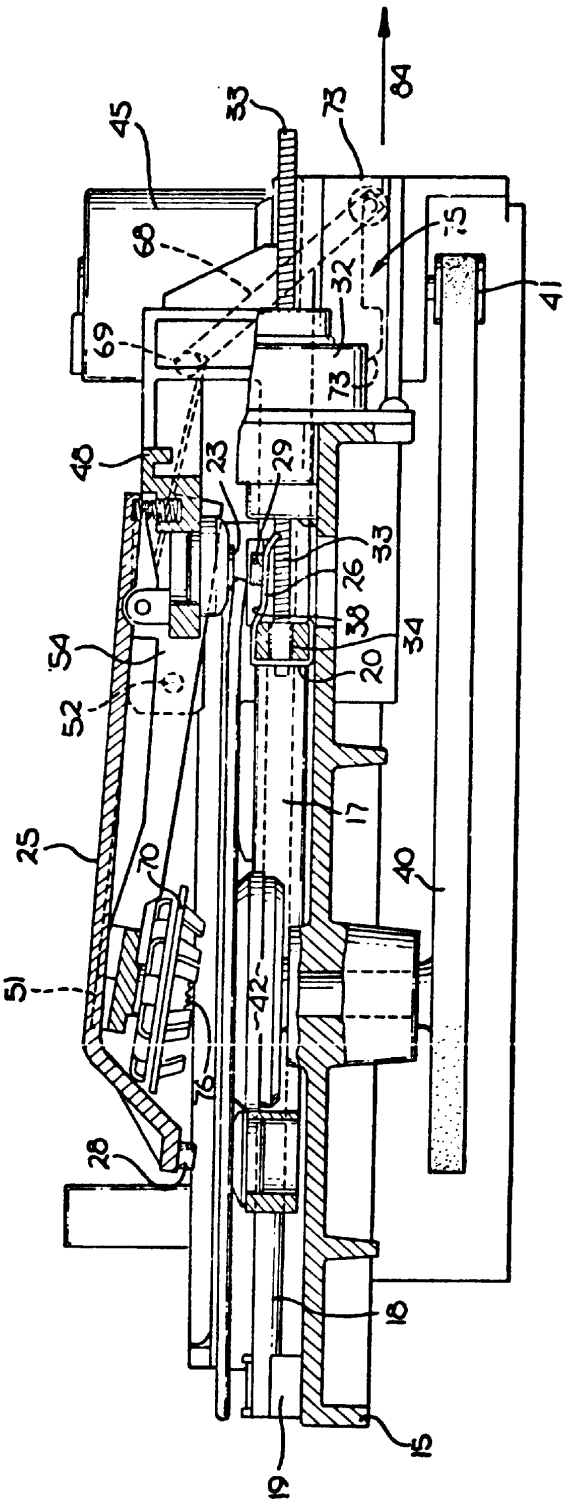

84
45
33
73
68
75
32
41
69
73
40
23
29
33
26
38
34
54
20
52
17
25
70
40
51
42
76
28
18
15
19

Fig. 4

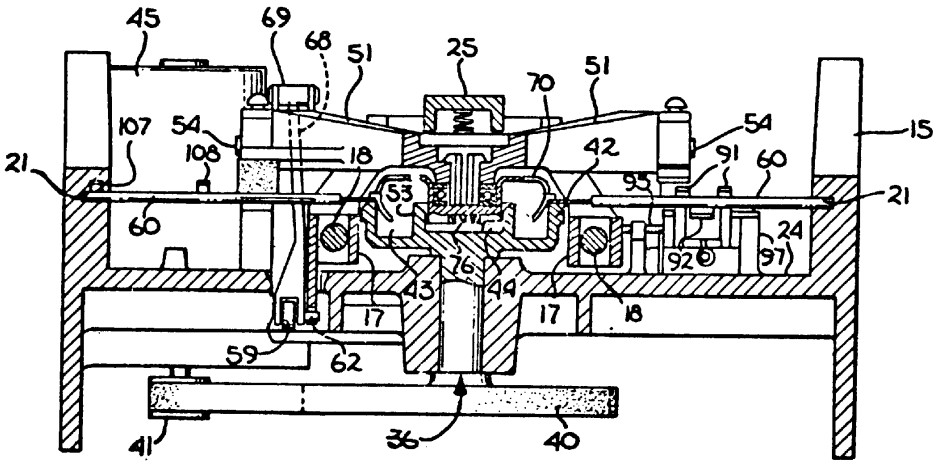


Fig. 5

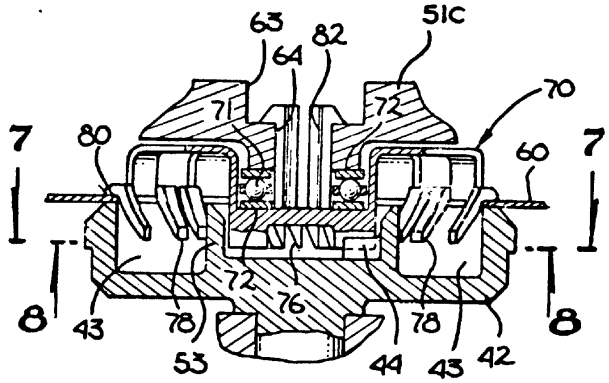


Fig. 6

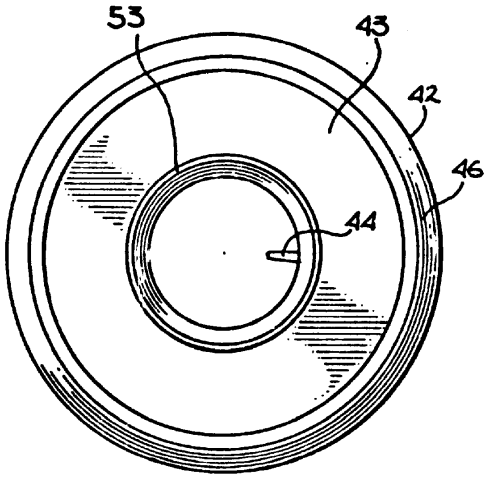


Fig. 7

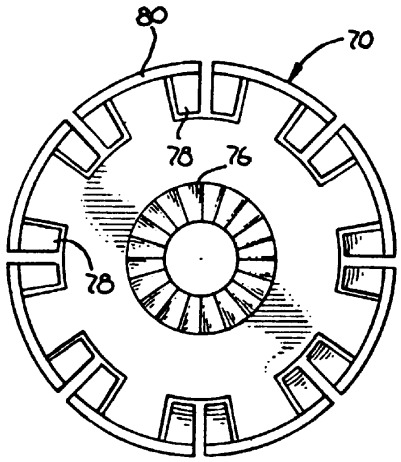


Fig. 8

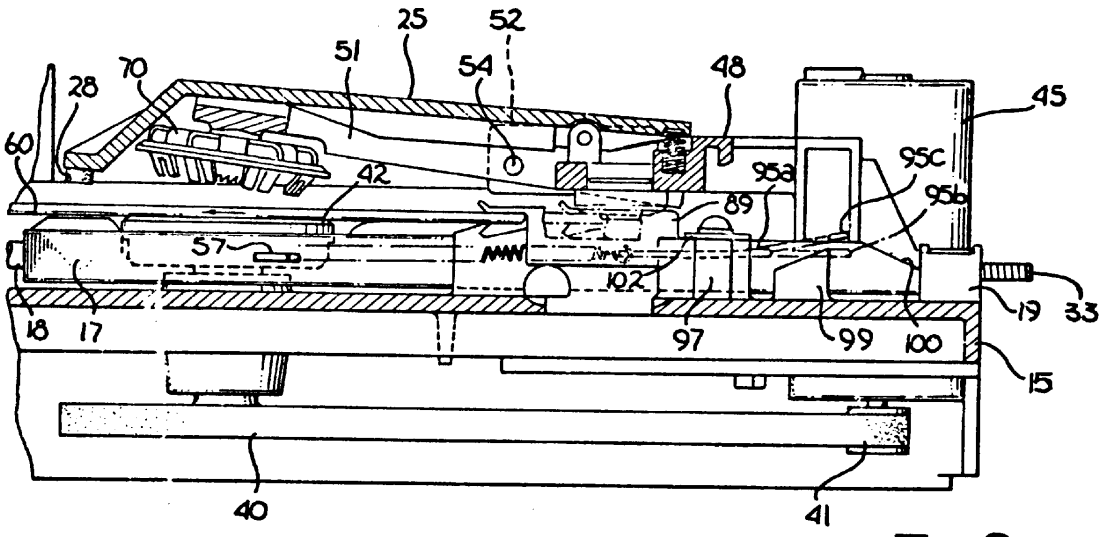


Fig. 9

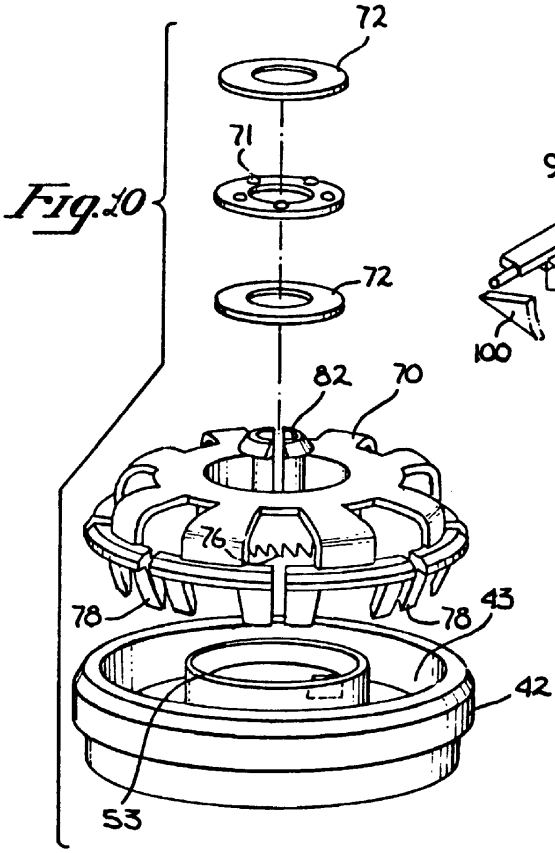


Fig. 10

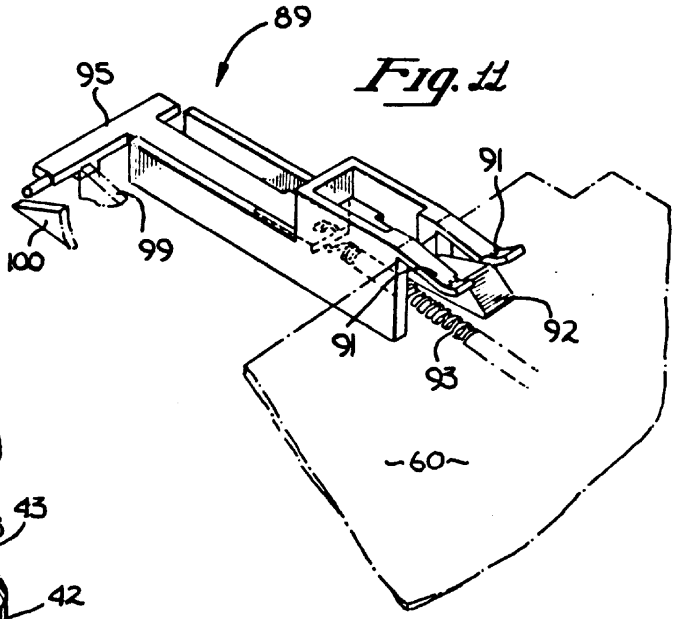


Fig. 11

DISK DRIVE WITH AUTOMATIC DISC CLAMPING AND EJECTING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to the field of drives for magnetic discs, particularly "floppy" disc.

2. Prior Art

There are numerous commercially available floppy disc drives which have been marketed in large quantities for several years. For the most part, these disc drives require that the disc be manually clamped once the disc is inserted (before rotation) and, manually removed after use. As will be seen, the invented disc drive provides automatic clamping of a disc, and also automatic ejection. Importantly, these two features are obtained without additional drive mechanisms. Both features result from movement of the linear actuator used to position the magnetic heads. Several attempts have been made to provide a reliable floppy disc drive at a reasonable cost which reads and writes information onto both sides of a disc. In one prior art disc drive, the upper and lower heads are disposed one directly above the other. This has proven to be a cumbersome and unreliable arrangement, particularly since it requires movement of one of the heads in order to insert and remove the floppy disc. The invented disc drive permits access to both sides of the disc. With a unique arrangement of the magnetic heads, neither head is moved for the insertion or removal of a disc.

Floppy disc drives have become widely used in countless computer systems including the personal computer field. This wide distribution has increased the need for an inexpensive, yet reliable disc drive. As will be seen, the described disc drive is readily assembled with fewer critical parts when compared to prior art drives. The simplicity of the overall design provides improved reliability.

SUMMARY OF THE INVENTION

A floppy disc drive which includes automatic disc clamping and ejection is described. A drive assembly which includes a spindle assembly for engaging and rotating a disc is mounted on a base. A carriage assembly is secured on rails to the base for reciprocating movement under the control of a linear actuator. The carriage extends about opposite sides of the drive wheel. A first magnetic head is mounted on the carriage on one side of the drive wheel for engaging one surface of the disc. A second magnetic head is mounted on the carriage on the opposite side of the drive wheel for engaging the opposite side of the disc. Clamping means including a clamper, automatically engages the disc and drive wheel when the carriage is actuated. An overcenter mechanism disposed between the clamping means provides this automatic engagement and disengagement. A springloaded ejector is loaded by the manual insertion of the disc. A ramp on the carriage releases the ejector body when the carriage is moved into a predetermined position, thereby ejecting the disc.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of the invented disc drive showing the lifter arm in its lower position.

FIG. 2 is a cross-sectional elevation view of the disc drive of FIG. 1 generally taken through section line 2—2 of FIG. 1.

FIG. 3 is a cross-sectional elevation view of the disc drive of FIG. 1 generally taken through section line 3—3 of FIG. 1.

FIG. 4 is a cross-sectional elevation view of the disc drive of FIG. 1 showing the lifter arm in its raised position, this view is generally taken through the staggered section line 4—4 of FIG. 1.

FIG. 5 is a cross-sectional front view of the disc drive taken generally through section line 5—5 of FIG. 1.

FIG. 6 is an exploded view of a portion of the spindle assembly of FIG. 5.

FIG. 7 is a plan view of the drive wheel of the spindle assembly, generally taken through section line 7—7 of FIG. 6.

FIG. 8 is a plan view of the clamper taken generally through section line 8—8 of FIG. 6.

FIG. 9 is a cross-sectional elevation view of the disc drive taken generally through section 9—9 of FIG. 1. This view is used to show the movement of the ejector mechanism.

FIG. 10 is a perspective view showing, in assembly form, the clamper, drive wheel and clamper trust bearing.

FIG. 11 is a perspective view showing the ejector body and its engagement with a disc.

FIG. 12 is a vertical cross-section of a photo-sensor assembly used to calibrate the position of the carriage.

DETAILED DESCRIPTION OF THE INVENTION

A disc drive is described which is particularly suitable for use with floppy discs. In the following description, numerous specific parts are described in detail in order to provide a thorough understanding of the present invention. However, it will be obvious to one skilled in the art that the inventive concepts described may be employed without the described embodiments. In other instances, well-known parts have not been described in detail in order not to obscure the present invention in unnecessary detail.

The main components of the invented disc drive generally comprise: (1) a base 15 shown well in the cross-sectional elevation view of FIG. 5; (2) a spindle assembly 36 which includes the drive wheel 42 and the related drive motor and pulleys also shown in FIG. 5; (3) a carriage 17, driven by a linear actuator which includes motor 32, the magnetic heads 22 and 23 are affixed to this carriage (See FIG. 1); (4) a lifter arm 51 which includes a clamper 70 for clamping a disc to the drive wheel 42 (See FIG. 1); and, (5) an ejector mechanism for ejecting a disc which includes the ejector body 89 of FIG. 11. Other miscellaneous components include function switches 107 and 108 and other parts as shall be described.

In the presently preferred embodiment the body 15 (See FIG. 1 and FIG. 5) is a generally elongated, H-shaped metal casting which includes an upper surface 24 on which the carriage assembly and lifter arm are mounted. A hub and centrally disposed bore are formed in the body 15 allowing it to receive the spindle assembly 36. Grooves 21 are formed on opposite inner surfaces of the upright sides of the body 15 so that a disc 60 may be retained within the body. Numerous other attaching points, bosses, and the like are integrally formed

with the body 15; they are described below, where pertinent to the present invention.

The spindle assembly includes at its upper end, a drive wheel 42 best illustrated in FIGS. 5, 6, and 7. The wheel 42 is coupled through a shaft to a flywheel 40. Bearings are provided to allow the wheel, shaft and flywheel 40 to rotate freely within the body 15. The upper surface of the wheel 42 includes an annular surface 46, the inner circumference of which aligns with the centrally disposed bore of a floppy disc. A recess 43 is defined by the wheel 42 within the interior of the annular surface 46. Fingers 78 from the clamper 70 extend into this recess as will be described. As best shown in FIGS. 7 and 10, a centering cylinder 53 extends upward from the central portion of the wheel 42, which as will be discussed below, surrounds the central portion of clamper 70 during operation to insure direct coupling and alignment between wheel 42 and clamper 70. A radially disposed nub 44 extends upward from the interior of centering cylinder 53 to provide a direct drive coupling engagement with teeth 76 of clamper 70.

The rim of the drive wheel 40 is crowned to receive a belt which interconnects the drive wheel with a pulley wheel 41. This pulley wheel is directly driven by an electric motor 45. Once the motor is activated with a disc in place, the disc is rotated at a predetermined rate of rotation.

Referring primarily to FIGS. 1 and 4, the carriage 17 includes a lower, generally rectangular section and an integrally formed upper carriage section 48. The carriage 17 includes sleeves 20 which engage the rails 18. These rails are mounted at mounts 19 above the surface 24 of body 15. The carriage is thus able to move in a reciprocating fashion along the rails from one end to the other of the body 15. The carriage 17 includes a generally centrally disposed, elliptically shaped opening 39 (FIG. 1) which encircles the disc drive wheel 42.

The carriage is driven by a linear actuator which consists of a stepping motor 32, a lead screw 33 and a lead screw nut 34 which is attached to the carriage.

A pair of magnetic heads are affixed to the carriage on opposite sides of the drive wheel 42. The first head 22 is affixed to the forward portion of the carriage 17 (see FIG. 1) and faces upward so that it may contact the underside of a disc engaging the disc drive. The second magnetic head 23 is affixed to the upper carriage portion 48 and faces downward such that it may engage the upper surface of a disc. It is important to note that with this arrangement both heads remain fixed to the carriage; this allows the heads to remain at a precise fixed distance from one another.

A leaf spring 25 extends from the upper carriage portion 48 as best seen in FIG. 1 to a position above the magnetic head 22. A resilient pad 28 is affixed to the lower surface of the spring 25 over the head 22. The spring 25 urges the pad against the disc 60 assuring that the disc 60 contacts the head 22 when the lifter arm 51 is in its lower position. The spring 25 passes over a portion 51c (See FIG. 1) of the arm 51, and thus when the arm is raised, as best shown in FIG. 4, the pad 28 is moved away from the disc. This prevents interference between the disc and the pad 28 when the disc is inserted or removed. Another spring 26 (see FIG. 4) mounted to the carriage includes an upwardly facing resilient pad 29. Spring 26 urges the disc (through pad 29) against the head 23. The body 15 defines two downwardly facing cams 38. When the carriage is moved rearwardly (in the direction indicated by arrow 84) the spring 26 moves downward, away from the disc allowing the disc to be removed.

Referring to FIGS. 1, 2 and 4, the lifter arm 51, like the carriage, is a molded plastic member. This irregularly shaped member includes a U-shaped section centered at the portion 51c, and a forward extending beam 51a (FIG. 1). The U-shaped sections of the lifter arm 51 are mounted for pivotal movement on pivots 54. These pivots extend inwardly from the upstanding right-angle shaped supports 52 (FIG. 2). The supports 52 extend upwardly from surface 24 of base 15. One end of the U-shaped section of arm 51 is coupled to the base 15 through a spring 55 best seen in FIG. 2. This spring urges the arm into its raised position, for example, the pad 28 is moved away from head 22. The end of the other U-shaped section of arm 51 includes an overcenter mechanism 50.

As best seen in FIGS. 3, 4 and 5, the overcenter mechanism includes a leaf spring 67 which extends rearwardly from the arm 51. The spring is hinged at hinge 69 to an arm 68. The free end of arm 68 includes a wheel 59 which rolls on a horizontal surface of the base 15. The axle of this wheel (pin 62 of FIG. 5) extends into a slot 75. This slot is defined between two downwardly extending portions 73 of the carriage. When the carriage is moved to its full forward position, the pin 62 reaches the end of the slot 75 and then the wheel 59 is urged forward (overcenter) to the position shown in FIG. 3. In this position, the spring 67 urges the lifter arm 51 downward and this provides clamping pressure to assure that the disk rotates with the drive wheel 42. Once the overcenter mechanism is locked, the carriage can move to position the heads on the disk without unlocking the mechanism since slot 75 is wide enough to permit such movement. When the carriage is moved to its full rearward position as shown in FIG. 4, the pin 62 contacts the forward end of the slot 75 causing the overcenter mechanism to unlock and assume the position shown in FIG. 4.

The overcenter mechanism has been found to provide ample clamping pressure, and as is apparent, it operates without any manual assistance. Importantly, no additional actuators are required since the mechanism is actuated by the linear actuator used to position the heads on the disc.

The forwardly extending section 51a of the arm 51 (FIG. 1) includes a downwardly facing pad 66. This pad is positioned over a boss 65 which extends upwardly from the base 15. When the arm is in its lower position, the disc with its jacket is disposed between the boss 65 and pad 66. The pressure exerted by the pad against the jacket provides cleaning of the disk in a well-known manner.

Another resilient pad 27 (FIG. 1) is affixed to a lower surface of the arm 51 and when the arm is in its lower position, this pad urges the disc jacket against the disc to also provide cleaning. An upstanding portion of the body 15 extends upward below the pad 27 to provide a lower surface upon which the disc jacket rests.

The portion 51c of the lifter arm includes a pair of concentric bores 63 and 64, best seen in FIG. 6. Bore 64 receives the shaft 82 of the clamper 70. The annular shoulder between the bore 63 and 64 provides a surface for locking the flared end of the split shaft 82.

The clamper, best seen in FIGS. 8 and 10, is a molded plastic part which includes the shaft 82 with its flared end, and a plurality of flexible fingers 78. In the presently preferred embodiment, clamper 70 is formed out

of NORYL 731, a tradename of the General Electric, Co. An annular surface 80 is formed about the fingers 78 and is made to cooperatively engage the surface 46 of the drive wheel 42. The clamper 70 includes a plurality of concentrically disposed teeth 76 which lockingly engage nub 44 to provide coupling between the clamper and the drive wheel. In operation, as will be discussed, the centering cylinder 53 surrounds the outside circumference of teeth 76 to insure that clamper 70 remains substantially centered in the middle of the spindle assembly, thereby maintaining the disk in an on-center configuration. A thrust bearing 71 is disposed between washers 72 on the shaft 82 when the clamper engages the bore 64. This permits the clamper to freely rotate below the arm 51.

One advantage to the clamper 70 is its ease of assembly onto the lifter arm. The washers and thrust bearing 71 are placed on the shaft 82 and then the shaft 82 is snapped into locking engagement within the bores 63 and 64. The shaft 82 is a split member; there is sufficient resiliency for the flared end of the shaft to readily pass through bore 64 before the flared end locks on the shoulder defined between bore 63 and 64.

Referring to FIGS. 1, 2, and 11, the ejector body 89 comprises an elongated molded plastic member defining upper claws 91 and a lower claw 92 at one end, and a perpendicularly disposed finger 95 at the other end. A notch 90 is cut into the disc jacket to allow claw 92 to more securely grip the jacket. The elongated ejector body 89 slides within a track 97. The track is defined by a an upstanding portion of the body member 15. A small plate 102 and a screw 101 retain the ejector body within the track 97. One end of a spring 93 is coupled to the ejector body; the other end of this spring is secured to the forward portion of the body 15. This spring urges the ejector body forward (towards the end of the drive which receives the discs).

The body 15 defines a forward sloping ramp 99, while the carriage includes a ramp 100. When a disc is inserted into the drive, the manual insertion of the disc urges the finger 95 over ramp 99 and causes it to be latched behind the ramp. The ramp 100 when moving in the direction of arrow 84, lifts the finger from its latched position, allowing the spring to move the body member forward thereby ejecting the disc. (Note when the ramp 100 moves in the direction opposite to arrow 84, it does not affect the latched finger 95.) The operation of the ejector mechanism shall be described in greater detail in conjunction with FIG. 9.

Referring now to FIG. 1, the disc drive includes function switches 107 and 108. When a disc is inserted into the drive, these switches are opened (the jacket moves the contacts apart) unless a notch is into the jacket. In FIG. 1, a notch 60a is shown around switch 108 to illustrate that with this notch, switch 108 remains closed. These switches may be used in a plurality of different ways. One switch is used for a protective function and prevents erasing of certain discs, for example, those containing programs. It will be appreciated that while switches 107 and 108 are used in the presently preferred embodiment, both switches may be replaced with a light emitting diode (LED) and photodector combination to achieve substantially the same result. Thus, upon insertion of a disk into the drive, the disk jacket would interrupt the beam emitted by the LED and thereby open or close the circuit in accordance with the particular function desired.

In operation, prior to the insertion of a disc, the carriage is driven by the linear actuator (motor 32 and lead screw 33) to its full rearward position as shown in FIG. 4. This causes the lifter arm 51 to be moved to its upward. In this position, the clamper 70 is moved clear of the drive wheel 42 and the pads, such as pad 28 and 29 are moved clear of the magnetic heads. A disc may be inserted into the disc drive along the grooves 21 shown in FIG. 5.

Once the disc is in place, the linear actuator is activated, causing the carriage to move forward. Upon the first forward movement of the carriage, the wheels 59 roll forward locking the overcenter mechanism (lifter arm down).

Referring to FIG. 6, with disc 60 inserted with the disc drive, the aperture of the disc should be concentric with the drive wheel 42. In this position, the edge of the disc aperture should precisely rest on annular surface 46. As clamper 70 moves downward, centering cylinder 53 surrounds the outer circumference of teeth 76 to insure that clamper 70 is precisely aligned with drivewheel 42. In practice, it has been found that without cylinder 53 nub 44 during operation tends to drive clamper 70 off-center relative to drive wheel 42. Typically, the fingers 78 of clamper 70 as they move downward into recess 43, urge the disc into concentric registry with the drivewheel. However, the use of centering cylinder 53 insures that precise alignment and a direct engagement between teeth 76 and nub 44 is achieved each time a disk is inserted.

With the clamper in its down position, the disc is held in place between the annular surface 80 of the clamper and the corresponding surface 46 of the drive wheel 42. Also, the nub 44 is urged into engagement with the teeth 76 of the clamper, thereby providing positive coupling between the clamper and the drive wheel. As will be appreciated, the direct coupling between the clamper and the drive wheel provides a driving force of equal magnitude on both surfaces of the disk. The springs 67 provide sufficient pressure to assure that the disc 60 rotates, without slippage, between with the drive wheel 42 and clamper 70.

With reference once again to FIG. 1, the linear actuator drives the carriage fully forward until a wedge shaped blade 57 formed integrally with the carriage interrupts a light beam within a calibration photo-sensor 58. Photo-sensor 58 is mounted, in the presently preferred embodiment, to the base 15 generally adjacent to the carriage near boss 65. As illustrated in FIG. 12, photo-sensor 58 is generally U-shaped and includes a photo-emitter 61, such as for example an LED, and a corresponding photo-detector 71. Emitter 61 and detector 71 are spaced apart so as to allow blade 57 to pass therebetween. Once the carriage moves forward sufficiently to interrupt the light beam, electrical circuitry driving motor 32 senses this interruption and the position of the carriage is calibrated. Thus, both magnetic heads are in predetermined positions with respect to the drive wheel and disc, such that the position of the carriage relative to the disc tracks may be determined after its subsequent movement along the rails 18.

The motor 45 may now be actuated and the disc brought up to speed. The carriage is moved by the linear actuator to the desired track to allow information to be read from or written onto the disc in a well-known manner. Of course, with the opposite facing heads 22 and 23 both sides of the disc can be accessed without removal of the disc.

When it becomes necessary to remove the disc, the linear actuator drives the carriage to its full rearward position as shown in FIG. 4, causing the lifter arm to raise, thereby freeing the disc.

Referring now to FIG. 9, as mentioned, as the disc is initially inserted, the ejector body 89 is moved rearwardly tensioning spring 93. The finger 95 is shown in three positions in FIG. 9 to illustrate its movement. Finger 95*a* illustrates the position of the finger when the disc is first inserted. As the ejector body is moved rearwardly by the disc the finger moves over the ramp 99 and locks behind the ramp as shown by finger 95*b*. When the ramp 100, which is part of the carriage, moves rearwardly, it urges the finger over the ramp (finger 95*c*) allowing the spring 93 to pull the ejector body forward, ejecting the disc. Angle 96 illustrates the ejector cam angle, formed when the ramp 100 urges the finger from behind the ramp 99.

Thus, a disc drive has been described which permits access to both sides of a disc. A single linear actuator drives both magnetic heads, provides clamping for the disc and triggers the ejector mechanism. The disc drive has numerous features which makes it easy to assemble and which provide high reliability.

We claim:

1. A disc drive comprising:

a base;

a drive assembly including a drive wheel for engaging and rotating a disc, said drive assembly being mounted to said base;

a carriage assembly mounted on said base for reciprocating movement;

a linear actuator coupled to said base for driving said carriage in said reciprocating movement;

at least one magnetic head mounted on said carriage for engaging said disc;

a lifter arm pivotally mounted on said base;

a clamper rotatably mounted on said lifter arm such that as said lifter arm pivots toward said drive wheel, said clamper is brought into engagement with said drive wheel with said disc therebetween to assure rotation of said disc with said drive wheel;

an overcenter mechanism disposed between said arm and said base, said overcenter mechanism being coupled to said arm to control the pivotal movement of said arm, said mechanism being capable of movement actuated by said reciprocating movement of said carriage such that movement of said carriage to its full rearward position causes pivotal movement of said arm, said pivotal movement occurring only when said carriage is at its full rearward position, thereby causing said clamper to move into said engagement with said drive wheel and to lift from said engagement,

whereby said disc is automatically clamped for rotation when said linear actuator is actuated.

2. The disc drive defined by claim 1 wherein said drive wheel includes an annular outer surface upon which said disc rests and a recessed surface within said annular surface, and wherein said clamper includes an outer annular surface for engaging said annular surface of said drive wheel.

3. The disc drive defined by claim 2 wherein said clamper includes resilient fingers which extend into said recess of said drive wheel when said clamper is in said engagement with said drive wheel, said fingers for providing alignment of said disc on said drive wheel.

4. The disc drive defined by claim 3 including a thrust bearing disposed between said clamper and said lifter arm.

5. The disc drive defined by claim 1 including coupling means on said clamper and said disc wheel to assure rotation of said clamper with said drive wheel when said clamper is in said engagement with said drive wheel.

6. The disc drive defined by claim 1 wherein said carriage extends about opposite sides of said drive wheel and wherein said one magnetic head is mounted on said carriage on one side of said drive wheel to engage one surface of said disc and wherein a second head is mounted on said carriage on the opposite side of said drive wheel to engage the opposite side of said disc.

7. The disc drive defined in claim 1 further comprising:

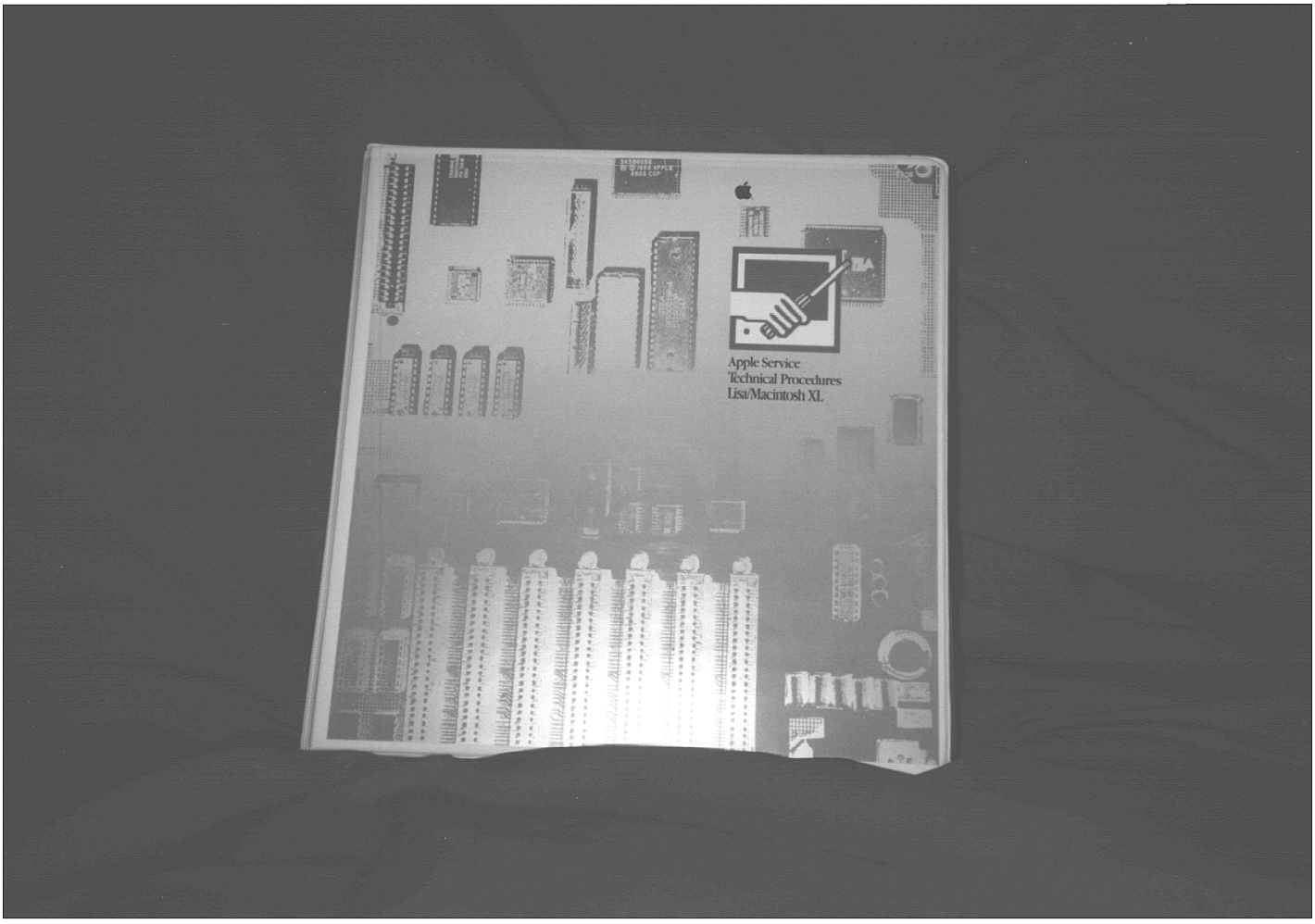
an ejector means for ejecting said disc from said disc drive, said ejector means being tripped by said carriage movement thereby causing said disc to be ejected,

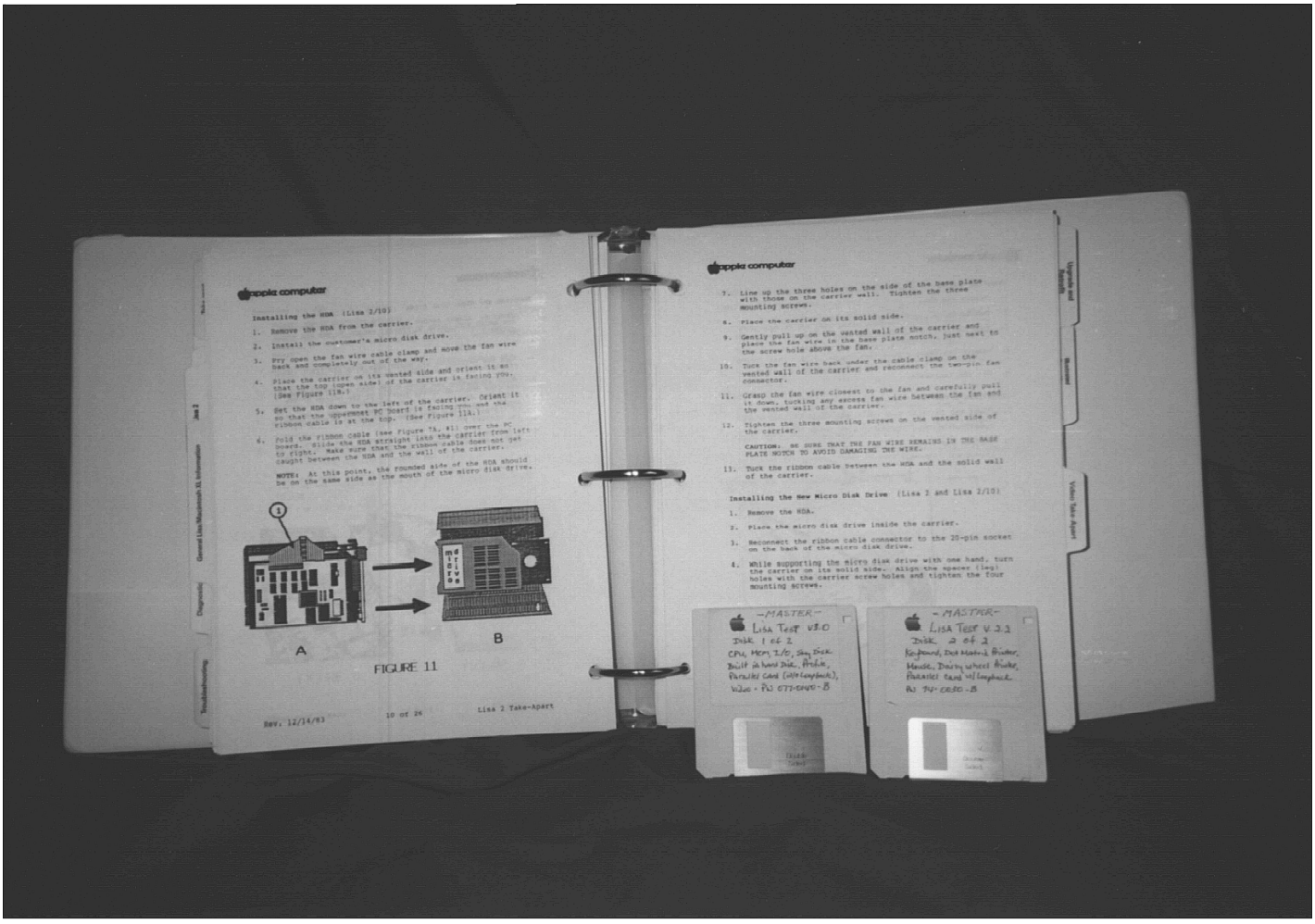
whereby said disc is automatically clamped and ejected by movement of said carriage.

8. The disc drive defined in claim 7 wherein said ejector means is spring-loaded by the manual insertion of said disc into said disc drive.

9. The disc drive defined by claim 8 wherein said tripping of said ejector means is caused by a ramped surface on said carriage.

* * * * *


Apple Service
Technical Procedures
Lisa/Macintosh XL



Installing the HDA (Lisa 2/10)

1. Remove the HDA from the carrier.
2. Install the customer's micro disk drive.
3. Pry open the fan wire cable clamp and move the fan wire back and completely out of the way.
4. Place the carrier on its vented side and orient it so that the top (open side) of the carrier is facing you. (See Figure 11A.)
5. Set the HDA down to the left of the carrier. Orient it so that the uppermost PC board is facing you and the ribbon cable is at the top. (See Figure 11A.)
6. Fold the ribbon cable (see Figure 7A, #1) over the PC board. Slide the HDA straight into the carrier from left to right. Make sure that the ribbon cable does not get caught between the HDA and the wall of the carrier.

   NOTE: At this point, the rounded side of the HDA should be on the same side as the mouth of the micro disk drive.

A B

FIGURE 11

Rev. 12/14/83 10 of 24 Lisa 2 Take-Apart

7. Line up the three holes on the side of the base plate with those on the carrier wall. Tighten the three mounting screws.
8. Place the carrier on its solid side.
9. Gently pull up on the vented wall of the carrier and place the fan wire in the base plate notch, just next to the screw hole above the fan.
10. Tuck the fan wire back under the cable clamp on the vented wall of the carrier and reconnect the two-pin fan connector.
11. Grasp the fan wire closest to the fan and carefully pull it down, tucking any excess fan wire between the fan and the vented wall of the carrier.
12. Tighten the three mounting screws on the vented side of the carrier.

    CAUTION: BE SURE THAT THE FAN WIRE REMAINS IN THE BASE PLATE NOTCH TO AVOID DAMAGING THE WIRE.
13. Tuck the ribbon cable between the HDA and the solid wall of the carrier.

Installing the New Micro Disk Drive (Lisa 2 and Lisa 2/10)

1. Remove the HDA.
2. Place the micro disk drive inside the carrier.
3. Reconnect the ribbon cable connector to the 20-pin socket on the back of the micro disk drive.
4. While supporting the micro disk drive with one hand, turn the carrier on its solid side. Align the spacer (leg) holes with the carrier screw holes and tighten the four mounting screws.

-MASTER-
Lisa Test v3.0
Disk 1 of 2
CPU, Mem, I/O, Sky Pick, Built in hard Dsk, Profile, Parallel Card (w/Loopback), Video - PN 677-6445-B

-MASTER-
Lisa Test v 3.1
Disk 2 of 2
Keyboard, Dot Matrix Printer, Mouse, Daisy wheel Printer, Parallel Card w/loopback
PN 677-6850-B