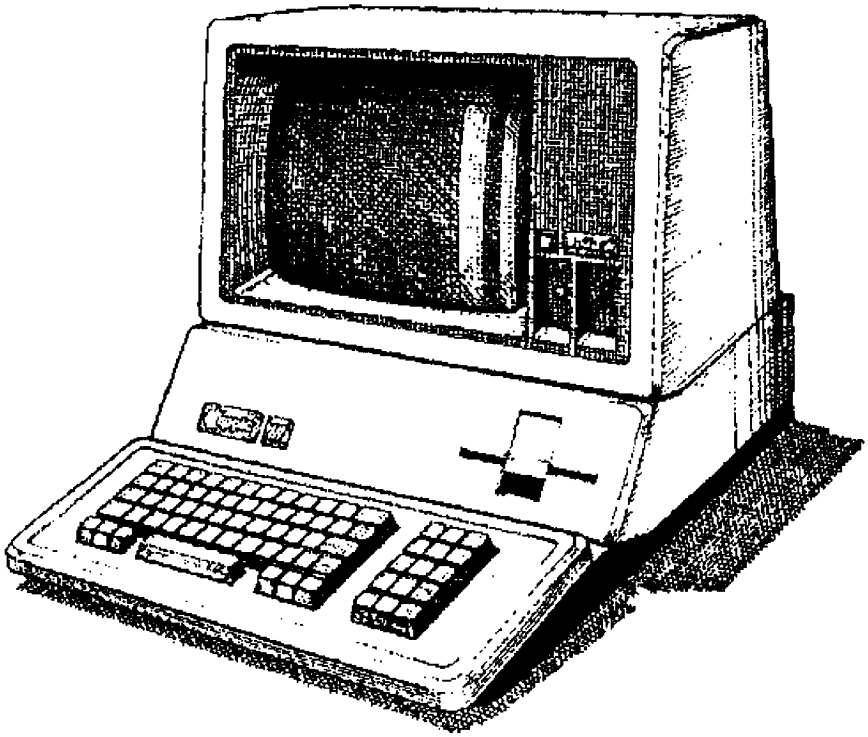
Apple /// Computer Information

Apple /// Service Reference Manual



Section II of II • Servicing Information

Chapter 13 • Testing and Troubleshooting

Written by Apple Computer • 1982

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Title: Apple /// Final Test

Purpose: This test is for the assembled Apple /// and for testing Apple /// modules.

A. Equipment:

1. B/W Monitor with cable
2. Color Monitor, Sup'r'mod II, and adaptor (make your own adaptor)
3. (3 cables) External Disk. Paddle Port, External Speaker Cables
4. External Speaker Test Box
5. RS-232 Test Adaptor
6. Printer test card
7. (4 each) Interrupt test cards
8. Apple /// Test Diskette (889-0009 rev R)

B. Equipment Setup for Part 1 of test: (Note: Unless noted otherwise, ALWAYS make sure that the power is OFF, before connecting or disconnecting ANYTHING from the Apple ///.)

1. Connect all of the power cords to a suitable AC outlet. Note: Make sure that all power switches are in the OFF position before plugging in any equipment.

2. Connect the B/W monitor cable to the RCA video output jack.

3. Connect the Color Monitor/Sup'r'mod II to the DB-15 jack.

4. Connect the joystick as follows:
   a. Connect the paddle port cable connector to the external disk drive socket.
   b. Connect the 2 DB-9 plug to the 2 DB-9 sockets. (The one with the shortest cable connects to the socket nearest the external drive connector, Port A. The other connects to Port B.

5. Plug one Interrupt test card into each of the four slots on the Apple /// logic board.

6. Plug the RS-232 Test Adaptor into the DB-25 connector on the logic board. (P/N 890-0130)

7. Insert the Apple /// Test Diskette into the drive and close the drive door.

C. Test Procedure: (for part 1 of the test.)
Follow the test procedure described in this section. The test should run as described. If there is a failure, some of the tests will automatically proceed to the next test, while others will require the operator to press certain keys, to tell the system what has failed. Proceed through all of the tests. If the system will not proceed through all of the tests, indicate on the RRT which test failed. Reject and repair any unit which does not perform as described in this procedure.

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*TEST DISKETTES HAVE BEEN KNOWN TO CRASH - KEEP AN EXTRA COPY ON HAND

1. Power On. Turn the power supply switch on. The unit will perform a self test first. If the self test passes, the disk will boot. If there is a failure in the self test, or the disk drive does not boot, record the failure on the RRT and send the logic board for rework. (ALWAYS TURN THE POWER OFF BEFORE DISCONNECTING ANYTHING FROM THE LOGIC BOARD.) When the disk drive boots, you will hear an audio signal of three beeps, followed by two beeps. You will then see a menu. Press the 1 key on the keyboard to run Automatic Test 1.

2. Interrupt test. The interrupt test will run automatically. If you see any of the following error messages, attempt to repair the A3 system and re-run the test. Write the failure down on the RRT.

ERROR MESSAGE.	SUGGESTED ACTION TO TAKE
unable to set or clear D.xxx	6522 at H-10 (U 73) *
unable to set or clear E.xxx	6522 at G-10 (U 97) *
(anything) from SLOT X	.check slot for bad connector

* locations will be as follows for the "NEW" logic board:

D.xxx	.6522 at B-6
E.xxx	.6522 at B-4

3. Video Test. The video tests will be loaded and run next. At the beginning of each test the screen will briefly display the name of the test being performed next and which keys to press, depending on the results. For reference, the following table lists the keys used for all of the video tests:

Space bar	Test passes
Return key	Test fails
Escape key	Abort video test (QUIT)
Left arrow key	Retry the test

Except for the text mode test, each of the tests will display the same pattern. A picture of Winston Churchill will appear in the upper right corner. The lower half of the screen will display the following message:

If you can read this, and
the test patterns above
are clear, press space bar.
Otherwise, press return.

a. HIRES MODE PAGE 1 - B & W pattern
b. HIRES MODE PAGE 2 - B & W pattern (same as above)
c. 280 x 192 COLOR HIRES MODE PAGE 1 - Will appear as a negative image. The color monitor will show red and black.

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d. 280 x 192 COLOR HIRES MODE PAGE 2 - Will appear as a green and white (or possibly green and yellow) pattern.
e. SUPER HIRES MODE PAGE 1 - B & W pattern (same as above)
f. SUPER HIRES MODE PAGE 2 - B & W pattern (same as above)
g. AHIRES TEST PAGE 1 - On this and the following test the screen will be divided into 4 horizontal sections, each one being a different color. The top half of Winston Churchill and the diagonal pattern should be VIOLET. The bottom half of Winston Churchill and the diagonal pattern should be BLUE. The first two lines of the message should be GREEN, and the last two lines of the message should be GOLD or ORANGE.
h. AHIRES TEST PAGE 2 - This test should display the same four color bars as the above test.
i. COLOR BAR 7 GRAY SCALE TEST - will show vertical bars of different colors on the color monitor and bars of varying brightness on the B & W Monitor. The border is blue and the colors are : (from left to right) white, aqua, yellow, green, pink, grey, orange, brown, light blue, medium blue, grey, dark green, light purple, dark blue, magenta, and black. These colors correspond to white darkening to black on the Black & White monitor. (IMPORTANT. Make sure that there are sixteen (16) different shades on the Black & White monitor.)
j. Apple II TEXT MODE PAGE 1 - The screen will display the following:

```
THE QUICK BROWN FOX JUMPS OVER LAZY DOGS

abcdefghijklmnopqurstuvwxyz   0123456789
                               (inverse)

        . . .

    (flashing)
```

k. APPLE II TEXT MODE PAGE 2 - The screen will show the following:

```
2222222222222222222
2222222222222222222
2222222222222222222
                222
                222
                222
2222222222222222222
2222222222222222222
2222222222222222222
222
222
222
2222222222222222222
```

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2222222222222222222
2222222222222222222

1. APPLE /// 40 COLUMN TEXT MODE TEST - The screen will be filled with blocks of colors with the name of each color in each block.

m. APPLE /// 80 COLUMN TEXT MODE TEST - The screen will contain characters that are smaller than before. There will be 80 characters to a line. The characters may not appear clear on the color monitor, and this is OK. It is mainly important that they are clear on the B & W monitor. The first line of the display should read:

THIS LINE OF TEXT IS EXACTLY 80 CHARACTERS
LONG AND USES THE ENTIRE SCREEN WIDTH

4. Keyboard Test. This test will load and display a pattern on the screen.

a. Main Keyboard. Press the Left shift key and while holding it down press the 2 key. Press the Right shift key and while holding it down press the = key.
Press the ctrl key and while holding it down press the A key.
Press all of the remaining keys on the MAIN key board.
Each time a key is pressed its character should disappear from the screen. Press the space bar last.

b. Numeric Keypad. A new pattern should appear on the screen which corresponds to the numeric keypad. This test should perform the same as the main keyboard test.

c. Special Function Keys.
   1. Press the Alpha-Lock key ONCE. It should lock into its new position.
   2. Press the space bar and hold it down.
   3. While still holding the space bar, press and hold both apple keys at the same time.
   4. Release all of the keys at the same time.
   5. Press the solid apple key and hold it down.
   6. While still holding down the solid apple key, press the space bar and hold it down.
   7. Release all of the keys at the same time.

d. Keyboard Interrupt test. Press any key on the keyboard except the alpha-lock, shift, control, or either of the apple keys to perform this test.

5. Clock/Calendar Test: This test is available for testing the clock/calendar when it becomes incorporated into the system.

6. Serial Port Test: This test will also load and run automatically. If it fails, replace the ACIA chip (6551) and run the test again. If it still fails, write ACIA on the RRT and repair the main

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logic board.

7. Joystick Port test: This test will run automatically. If any failures should occur, write the failure message on the RRT.

8. Test Results: The screen should show the following results:

TEST RESULTS

A.	INTERRUPT	(PASSED)
B.	VIDEO	(PASSED)
C.	KEYBOARD	(PASSED)
D.	CALENDAR/CLOCK	(NOT TESTED)
E.	ACIA PORT	(PASSED)
F.	PADDLE PORTS	(PASSED)
G.	RAM	(NOT TESTED)
H.	PRINTER PORT	(NOT TESTED)
I.	DISK	(NOT TESTED)
J.	SOUND	(NOT TESTED)
K.	ROM	(NOT TESTED)

1. AUTOMATIC TEST 1
2. AUTOMATIC TEST 2
ESC ABORT TESTING

Tests A through F should always show passed, (except for test D) and tests G through K and test D should always show not tested. If any of tests A through F show failed, mark the RRT with the test that failed. If all of tests A through F show passed, proceed with part 2 of the Final test.

D. Equipment Setup for part 2 of test:

1. TURN THE POWER OFF!
2. Remove the following items from the logic board:
   a. The joystick cables
   b. The four interrupt test cards.
   c. The RS-232 test adaptor.
   d. The DB-15 video connector
3. Plug the Printer Test Card into slot 1, and connect the printer cable to the DB-9 connector nearest the disk drive sockets and the other cable to the external disk drive socket. Connect the external speaker plug to the 2-pin connector on printer test card.

E. Test Procedure: (for part 2 of the test.)
Please follow the test procedure described in this section. The test should run as described. Reject any assembly or unit which does not perform as described in this procedure. Complete all of the tests if possible. If the system will not perform any test, indicate on the RRT which test failed and diagnose, repair, and retest.

1. POWER ON. Turn the power on and the unit should perform

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a self-test and boot just as it did earlier. If there is a failure in the self-test or the drive does not boot, record the failure on the RRT and repair. ALWAYS TURN THE POWER OFF BEFORE DISCONNECTING ANYTHING FROM THE LOGIC BOARD. After the disk boots, a menu will appear on the screen. Press the 2 key to run automatic test 2.

2. Ram Address Test. This test will load and run automatically. The test results will depend on the amount of ram in the memory board. If the memory board is a 256K board the results should say "RAM MAP GOOD FOR A 256K SYSTEM". If the correct message appears, press the space bar, otherwise press the return key. Faulty RAM chips are reported in a message that identifies the board location of the chip in error.

   Note: If a fault is discovered while testing the RAM on the 12 volt board, disregard the chip referred to in the error message and run the Final Test Revision 14. Revision 14 will correctly identify the chip in error. Revision R reports bad chip locations as defined on the 5 volt board and these messages are innaccurate for the older board.

   If the space bar is pressed the system will perform a test on all of the ram in the system and report any failures. For this reason it is very important for you to have made the correct decision for the ram map address test above. If the system is a 256K system and the ram map says good for a 128K system and you press the space bar, only half of the ram will be tested and you may incorrectly PASS a system which FAILED.

3. Printer Port Test. This test will run automatically.
4. Disk Controller Test. This test will run automatically.
5. Sound Test.
   a. C030 SOUND TEST - The speaker will beep on and off.
   b. C040 SOUND TEST - The speaker will beep on and off as before but at a different pitch. Press the space bar if you hear the sound, and return if you do not.
   c. Connect the external speaker cable from the printer port test card to the external speaker jack on the back of the Apple /// and press the return key.
   d. FFE0 SOUND TEST - The sound from the speaker should start quietly and grow gradually louder. It should then repeat. Press the space bar if it performs as described here, and press the return key if it does anything else. The sound should be coming from the EXTERNAL speaker.
   e. Disconnect the external speaker cable from the logic board and press return. (NOTE: These are the ONLY times that you can connect or disconnect anything from the Apple /// with the power still on, and the ONLY thing that can be connected or

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disconnected is the external speaker cable.)

f. The same sound as the previous test should be heard. The sound should come from the INTERNAL speaker again.

6. Rom Test. This test will load and run automatically.
7. Test Results: The screen should show the following results:

TEST RESULTS

A. INTERRUPT	(NOT TESTED)
B. VIDEO	(NOT TESTED)
C. KEYBOARD	(NOT TESTED)
D. CALENDAR/CLOCK	(NOT TESTED)
E. ACIA PORT	(NOT TESTED)
F. PADDLE PORTS	(NOT TESTED)
G. RAM	(PASSED)
H. PRINTER PORT	(PASSED)
I. DISK	(PASSED)
J. SOUND	(PASSED)
K. ROM	(PASSED)

1. AUTOMATIC TEST 1
2. AUTOMATIC TEST 2

ESC ABORT TESTING

Tests A through F should always show not tested, and tests G through K should always show passed. If any of the tests G through K show failed, record which test failed on the RRT and repair the module under test.

8. Additional keyboard tests:
   a. Press any key and hold it down. The key should automatically repeat.
   b. While still holding the same key down, press the Apple key nearest the space bar and the repeating key should repeat at a faster rate. (Approximately twice the speed)
   c. Press the right arrow key and the cursor dot should move to the right. Press the key harder and it should move twice as fast.
   d. Repeat the same test with the left arrow and down arrow keys. They should behave in the same manner described for the right arrow key except that they will of course move left and down, respectively.
   e. Press and hold the ctrl key with some finger on your left hand and then press and hold the Apple Key next to the alpha lock with your left thumb. Use your other hand to press the Reset key. The system should respond with a right

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pointing arrow and a blinking line cursor.

f. If any of these keyboard tests do not perform exactly as described here, record the failure on the reject tag, and send the unit for rework.

F. If the logic board passes all of the tests as described above, turn the power off and complete the RRT. If any of the tests failed, record the appropriate information on the RRT and repair. Retest after repair.

G. If you have a system or module that passes all these tests but suspect it to have a failure run other software on the unit/modules. Examples: Business Basic, AII Emulation, A /// Dealer Diagnostic.

PRE-RELEASE VERSION

16 SECTOR DISK III FINAL TEST (1000T)

DESCRIPTION

1000T is a general purpose internal disk exercizer. It performs 1000 reads of ramdomly selected tracks on the disk. It is to be used as a diagnostic tool and not as a qualification/acceptance test. The rest of this document provides a short description of how to interpret the displayed results.

When you first boot this diskette you will observe:

"*** 16 SECTOR DISK III FINAL TEST ***"

This will indicate that the test booted up correctly with no problems. You will then observe the following:

		TRACK ERRORS				
3	(0)	0	*	19	(0)	0
4	(0)	0	*	20	(0)	0
5	(0)	0	*	21	(0)	0
6	(0)	0	*	22	(0)	0
7	(0)	0	*	23	(0)	0
8	(0)	0	*	24	(0)	0
9	(0)	0	*	25	(0)	0
10	(0)	0	*	26	(0)	0
11	(0)	0	*	27	(0)	0
12	(0)	0	*	28	(0)	0
13	(0)	0	*	29	(0)	0
14	(0)	0	*	30	(0)	0
15	(0)	0	*	31	(0)	0
16	(0)	0	*	32	(0)	0
17	(0)	0	*	33	(0)	0
18	(0)	0	*	34	(0)	0

TOTAL:	SEEK:	DATA:
TIME:	ADDR:	AVER:

WHAT DOES IT ALL MEAN?

The first column, numbered 3 to 18, and the column with numbers going from 19 to 34 represent track numbers. The column in brackets represents the number

of seek occurances that occur for each track. The column that has zeros is the number of errors that were encountered for each track. You will observe that each time a track is read, it is shown in inverse, the number of occurances is incremented. If any seek, address, or data errors are found the number of errors are displayed.

A summary of the disk test is displayed at the very bottom of the monitor screen. The following are definitions as to what the messages mean.

- o TOTAL: -- the total number of errors for all tracks
- o TIME: -- the number of track seeks performed for all tracks
- o SEEK: -- the total number of track seek errors observed for all tracks
- o ADDR: -- the total number of address errors observed for all tracks
- o DATA: -- the total number of data errors observed for all tracks
- o AVGE: -- the number of track seeks divided by the total number of errors observed for all tracks

NOTE: PLEASE MAKE BACKUP DISKETTES OF THIS 1000T DISKETTE

WHAT CAN THIS TOOL TELL ME?

This tool is useful for getting a good idea as to the performance of the A/// internal disk drive. Based on the results, 1000T can give you an indication of electrical and mechanical problems. Examples: Errors within a small range of tracks could indicate cam or rail problems. Multiple data errors could indicate head wear. Address/seek errors could indicate a poor motor control board. These examples are not absolute nor do they exhaust all possibilities. This tool is also very useful for debugging intermittant disk problems.

WARNING: Do not rely solely on this diskette as a pass/fail indicator. If you find very many errors, run other Disk tests such as the DSPEED and Disk Alignment Aide.

Catastrophic errors are easily to find - your monitor screen will display "FAILS TEST". Other than catastrophic errors your monitor screen will display "PASSED TEST" at the end of 1000 passes(seeks).

HAPPY HUNTING!!!

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APPLE /// TROUBLESHOOTING

The following flowchart is a guide for troubleshooting the Apple ///. You will carry out various troubleshooting steps based on symptoms that may occur when first booting up or that may be found by running the Dealer Service Diagnostics. Start with the instruction in Box 1 of the flowchart. Then follow the operation of the Apple /// through the flowchart until you reach one of the lettered boxes (A through Q). Each lettered box has a list of numbers in it; each number corresponds with one of the troubleshooting steps listed on the following page. The order of the troublshooting steps in each box is based on two rules:

1) Check out the more likely causes of the problem before the less likely causes.

2) Make the checks that can be done quickly and easily before those that take more time and energy.

Rule 1 is broken only when rule 2 applies.

Once you have produced the problem symptom on the Apple ///, the first thing you should do before trying any of the numbered steps below is:

a) Power OFF.

b) Check to make sure all connecting cables are properly hooked up.

c) Check all boards to make sure all IC chips are properly seated.

d) Power ON again to see if the problem still exists.

ALWAYS POWER OFF BEFORE PERFORMING ANY OF THE STEPS BELOW.
CARRY OUT THE DESIGNATED STEP.
THEN POWER ON AGAIN TO SEE IF THE PROBLEM HAS BEEN ELIMINATED.

Each swap step listed below involves exchanging a known good part from your spares kit with the questionable part from the Apple ///. When swapping, first just connect the cable(s) to the new module so you can see if the swap fixes things or not. Don't fully install the new module and screw everything down---if the new module doesn't solve the problem you'll just have to take it out again.

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HERE ARE THE STEPS REFERRED TO IN THE BOXES ON THE DIAGNOSTIC FLOWCHART:

1) Swap the appropriate connecting cable.
   V = Video cable (if available)
   PS = Power Supply cable
   DD = Disk Drive cable
   KB = Keyboard cable
   (The keyboard and disk drive cables are identical to each other. Your Spares Kit may only list the DD cable, but you can use it whenever you need to swap the KB cable.)

2) Swap the power supply.

   a) Check the power supply fuse first; swap it if it's burned out.

3) Swap the drive.

   If the drive proves to be the problem, take the problem drive and further isoloate the defective module down to the analog card or mechanical assembly:

   a) Swap the analog card.

   b) Swap the mechanical assembly.

4) Swap the main logic board.

5) Swap the keyboard.

6) Swap the RAM memory board. (You may have to reload the new board with the RAM from the original board.)

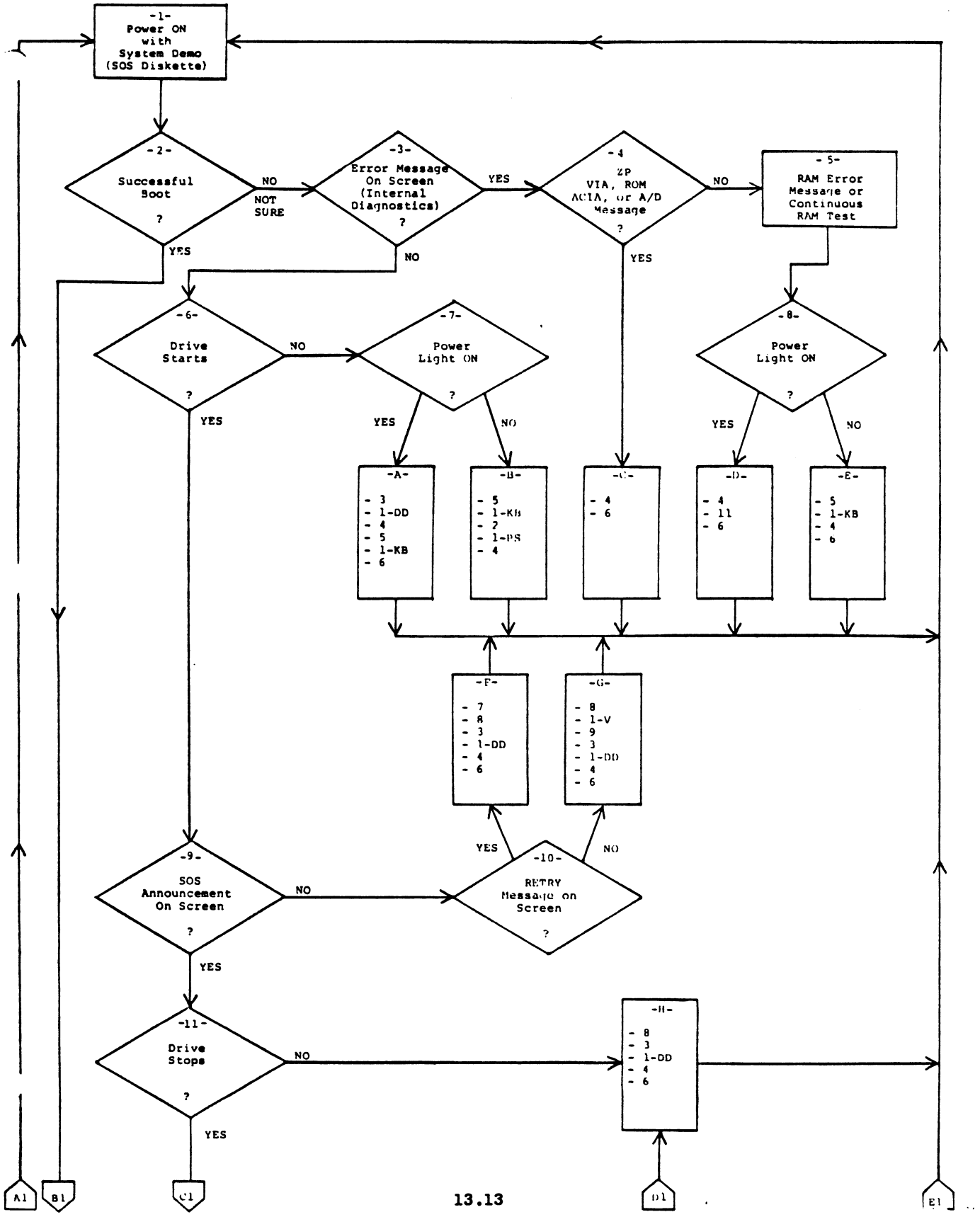
7) Try booting again.

8) Try booting a different SOS boot diskette.

9) Swap the video monitor (if you have a spare available).

10) Swap the speaker (if you have a spare available).

11) Swap (or add) the designated RAM IC chips. (Consult the chip map in the Running Diagnostics Job Aid.)


-1-
Power ON with System Demo (SOS Diskette)
-2-
Successful Boot ?
NO
NOT SURE
YES
-3-
Error Message On Screen (Internal Diagnostics) ?
YES
NO
-4
ZP VIA, ROM ACIA, or A/D Message ?
NO
YES
-5-
RAM Error Message or Continuous RAM Test
-6-
Drive Starts ?
NO
YES
-7-
Power Light ON ?
YES
NO
-8-
Power Light ON ?
YES
NO
-A-
- 3
- 1-DD
- 4
- 5
- 1-KB
- 6
-B-
- 5
- 1-KB
- 2
- 1-PS
- 4
-C-
- 4
- 6
-D-
- 4
- 11
- 6
-E-
- 5
- 1-KB
- 4
- 6
-F-
- 7
- 8
- 3
- 1-DD
- 4
- 6
-G-
- 8
- 1-V
- 9
- 3
- 1-DD
- 4
- 6
-9-
SOS Announcement On Screen ?
NO
YES
-10-
RETRY Message on Screen ?
YES
NO
-11-
Drive Stops ?
NO
YES
-H-
- 8
- 3
- 1-DD
- 4
- 6
A1
B1
C1
D1
E1

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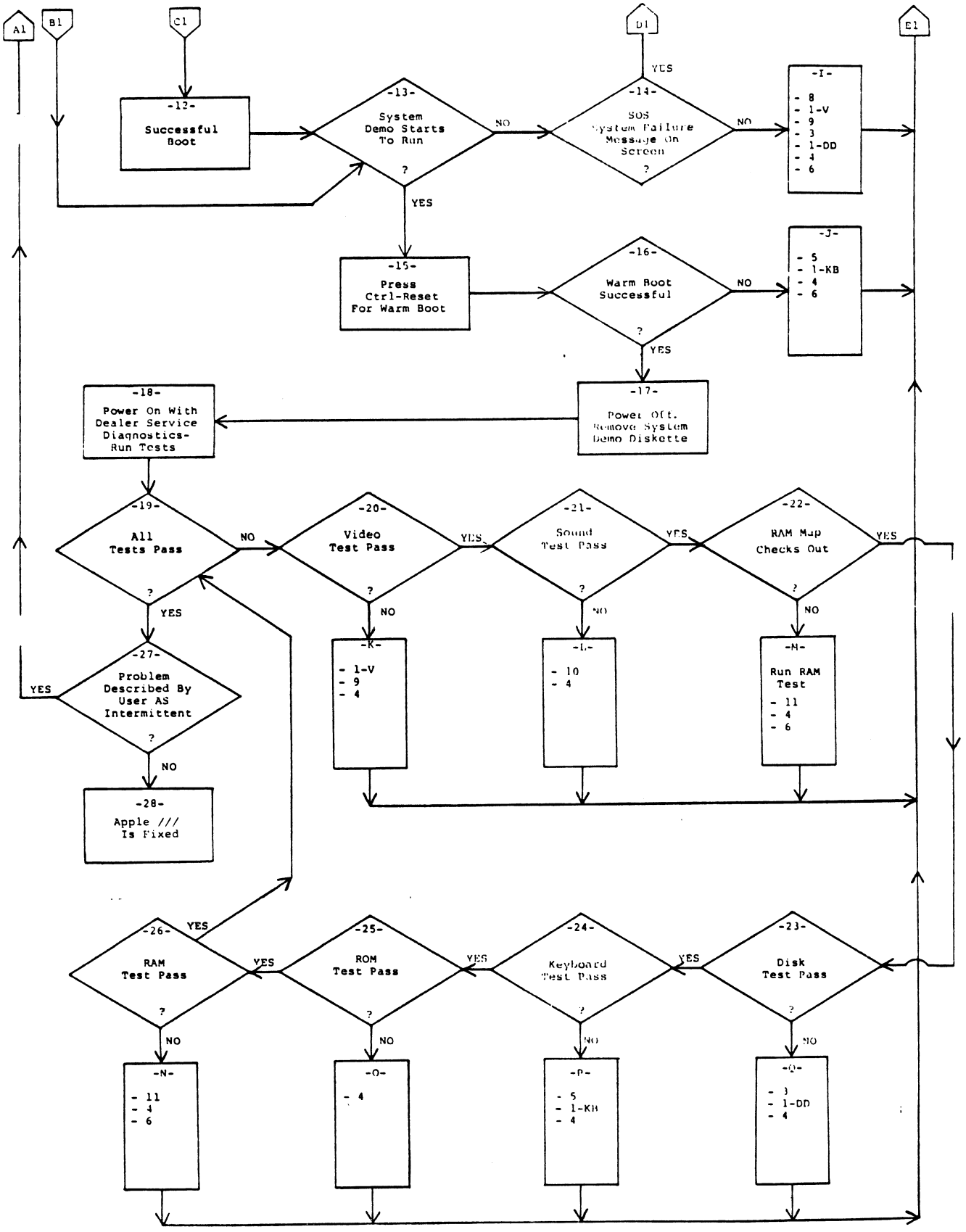
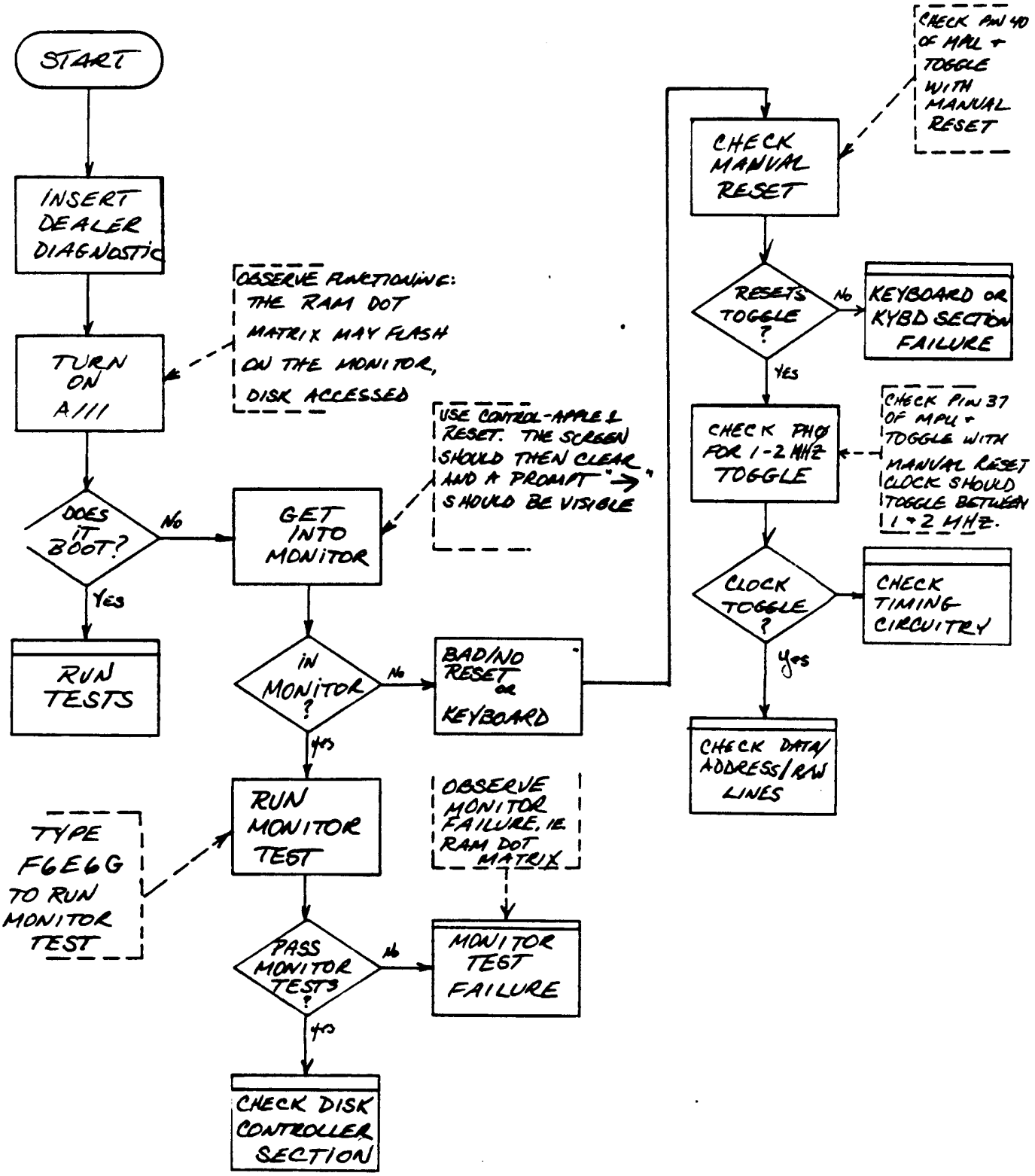

A1
B1
C1
D1
E1
-12-
Successful Boot
-13-
System Demo Starts To Run
?
NO
YES
-14-
SOS System Failure Message On Screen
?
NO
YES
-I-
- 8
- 1-V
- 9
- 3
- 1-DD
- 4
- 6
-15-
Press Ctrl-Reset For Warm Boot
-16-
Warm Boot Successful
?
NO
YES
-J-
- 5
- 1-KB
- 4
- 6
-17-
Power Off. Remove System Demo Diskette
-18-
Power On With Dealer Service Diagnostics- Run Tests
-19-
All Tests Pass
?
NO
YES
-20-
Video Test Pass
?
NO
YES
-21-
Sound Test Pass
?
NO
YES
-22-
RAM Map Checks Out
?
NO
YES
-K-
- 1-V
- 9
- 4
-L-
- 10
- 4
-M-
Run RAM Test
- 11
- 4
- 6
-27-
Problem Described By User AS Intermittent
?
YES
NO
-28-
Apple /// Is Fixed
-26-
RAM Test Pass
?
NO
YES
-25-
ROM Test Pass
?
NO
YES
-24-
Keyboard Test Pass
?
NO
YES
-23-
Disk Test Pass
?
NO
YES
-N-
- 11
- 4
- 6
-O-
- 4
-P-
- 5
- 1-KB
- 4
-Q-
- 3
- 1-DD
- 4

13.14

A/// NO BOOT FLOW DIAGRAM



13.15

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5V MEMORY BOARD RAM TROUBLESHOOTING PROCEDURE

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13.16

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5V VOLT MEMORY BOARD RAM TROUBLESHOOTING PROCEDURE

To start with, be sure that your problem is caused by the 5V Memory Card. Some problems on the motherboard of the Apple /// will cause the symptoms similar to those caused by a bad 5V Memory Card. To check, replace the Memory Card with a known good one and check to see if the symptoms have disappeared.

1) If the problem has been isolated to the Memory Card, reconnect the bad 5V Memory Card in the Apple /// system under test and try to boot the Apple /// Confidence Diskette Version 1.1.

2) If it boots, select the memory test.

3) Relate your system's symptoms to the symptoms on the Apple /// 5V Memory Card Troubleshooting Chart.

4) The corrective actions are listed in the order of most probable cause; therefore perform the corrective action in the order presented.

5) If all of the possiblities have been exhausted and the problem still exists, replace the bad 5V Memory Card with a good one and send the bad one back to a Level II repair center.

Note: This interim RAM troubleshooting procedure is to be used with the Confidence Diskette Version 1.1. The memory test, in the current Confidence Diskette, does not test each and every memory location in RAM. This procedure will be superceded by the next version of the A/// Dealer Diagnostic.

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Apple /// 5V Memory Card Troubleshooting Chart

Symptom	Recommened Action
Black Screen on Monitor; drive does not boot.	Replace RAM chips B10 - B17 one at a time; Replace the non-RAM chips at locations D2 and E2.
Monitor Screen contains garbage; Drive may try to boot.	Replace RAM chips B2 - B9 one at a time; Replace the non-RAM chips at locations D2 and E2.
Confidence Program loads into memory, displays menu, but will not run.	Replace the non-RAM chips at locations D2 and E2; Replace RAM chips B2 - B17 one at a time.
Memory test runs; displays RAM error message at the bottom of the screen.	Decode the message using the procedure on Page 4. Replace the failed RAM.
Memory test runs; sections of the memory map are missing.	Determine which section on the Memory Card contains the failed RAM using the procedure on page 8. Replace the RAM chips in that section one at a time; Replace non-RAM chips at locations D2 and E2.

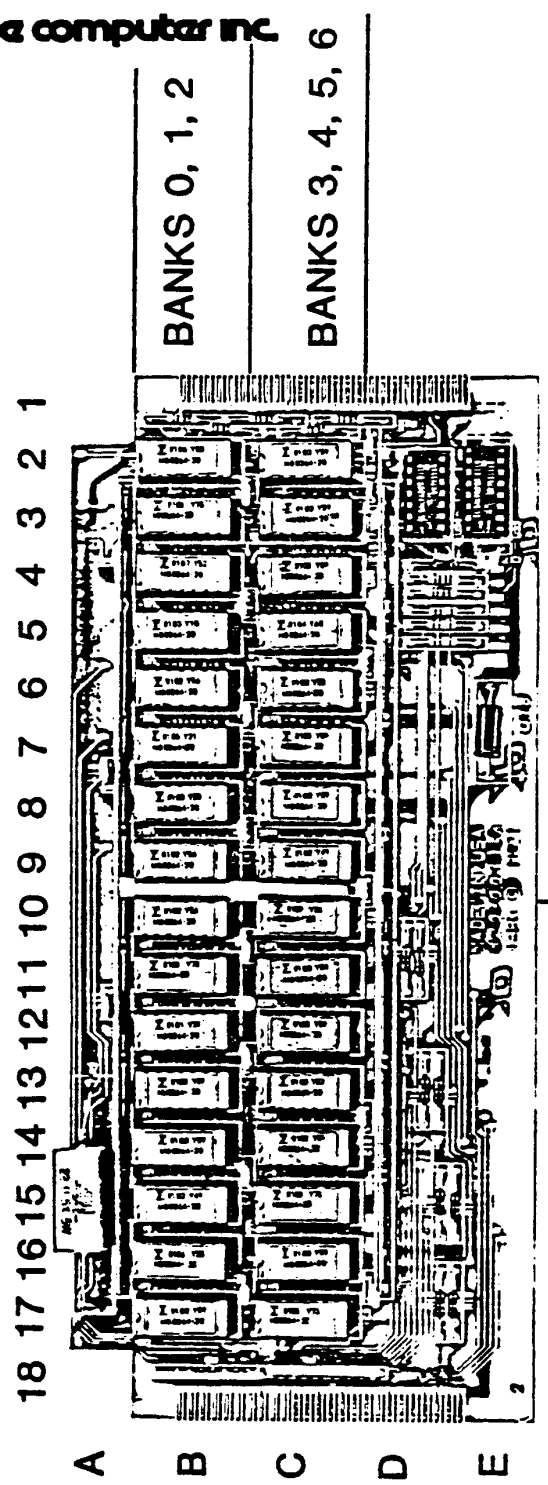

FIGURE 1

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TRANSLATING ERROR MESSAGES INTO PHYSICAL RAM LOCATIONS

When you get an error message from the RAM test, you must translate it to determine which chip caused the failure. This procedure will show you how to do that. For example, suppose we get the error message:

BNK 83, ADR 20XX, EXP DF, GOT 5F

That means in Bank 83, Address Range 20XX, we expected DF but got 5F.

Now, how do you translate that into what to do?

1) To find out which row the failed RAM chip is in, disregard the 8, and look at the second number, in this case 3. If the second number is 0, 1, or 2, the bank is in row B. If the second number is 3, 4, 5, or 6, the bank is in row C. (See Figure 1). In our example, the bank was BNK 83, so we know it is in row C.

2) Now the meaning of the address. There are three address ranges, low, middle, and high. Low and high are in columns 2-9, and middle is in columns 10-17. Look at Figure 1 for the specific address ranges. In our example, the address was 20XX (which is in the low address range), so we see that the trouble is in columns 2-9.

3) The problem is now narrowed down to a block of eight chips, the ones located in row C, columns 2 - 9 (positions C2 - C9). To find which of the eight it is, we have to decode the EXP and GOT parts of the message.

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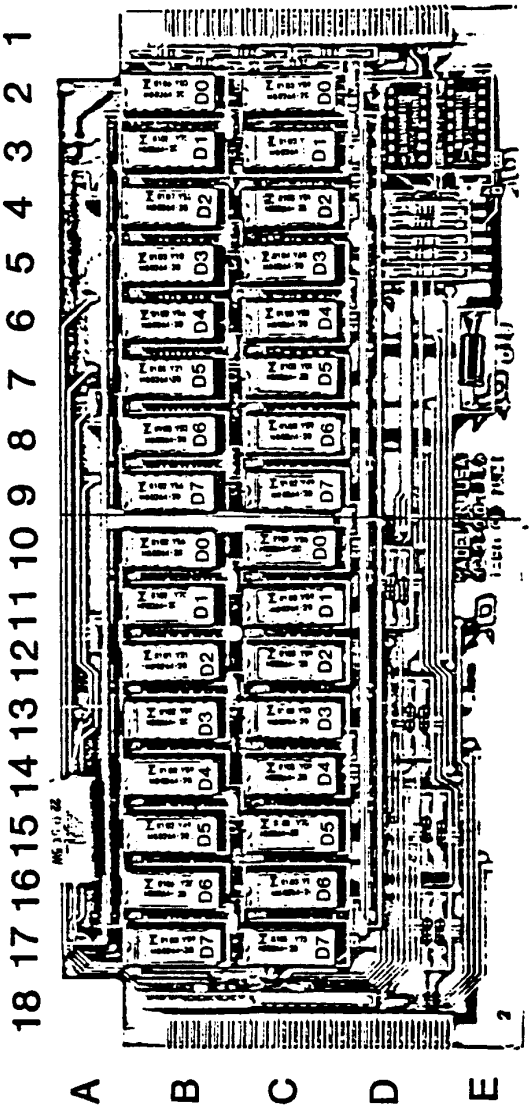

FIGURE 2

13.21

4) Translate the two hexadecimal digits from the EXP into binary.

HEX	BINARY	HEX	BINARY	HEX	BINARY	HEX	BINARY
0 =	0000	4 =	0100	8 =	1000	C =	1100
1 =	0001	5 =	0101	9 =	1001	D =	1101
2 =	0010	6 =	0110	A =	1010	E =	1110
3 =	0011	7 =	0111	B =	1011	F =	1111

EXAMPLE (DF): D=1101, F=1111, DF=11011111

5) Translate the two hexadecimal digits from the GOT onto binary.

EXAMPLE (5F): 5=0101, F=1111, 5F=01011111

6) Determine the binary digit (bit) that is different between the EXP and the GOT. The leftmost bit is D7 and the rightmost bit is D0. In our example the D7 bit is different. This indicates that the chip marked D7 in Figure 2 in the position C9 (remember, we already got it down to C2 - C9) is defective.

```
            D        76543210
EXAMPLE:   EXP     DF=11011111
           GOT     5F=01011111
                   ==========
                      X-------  (D7 is different)
```

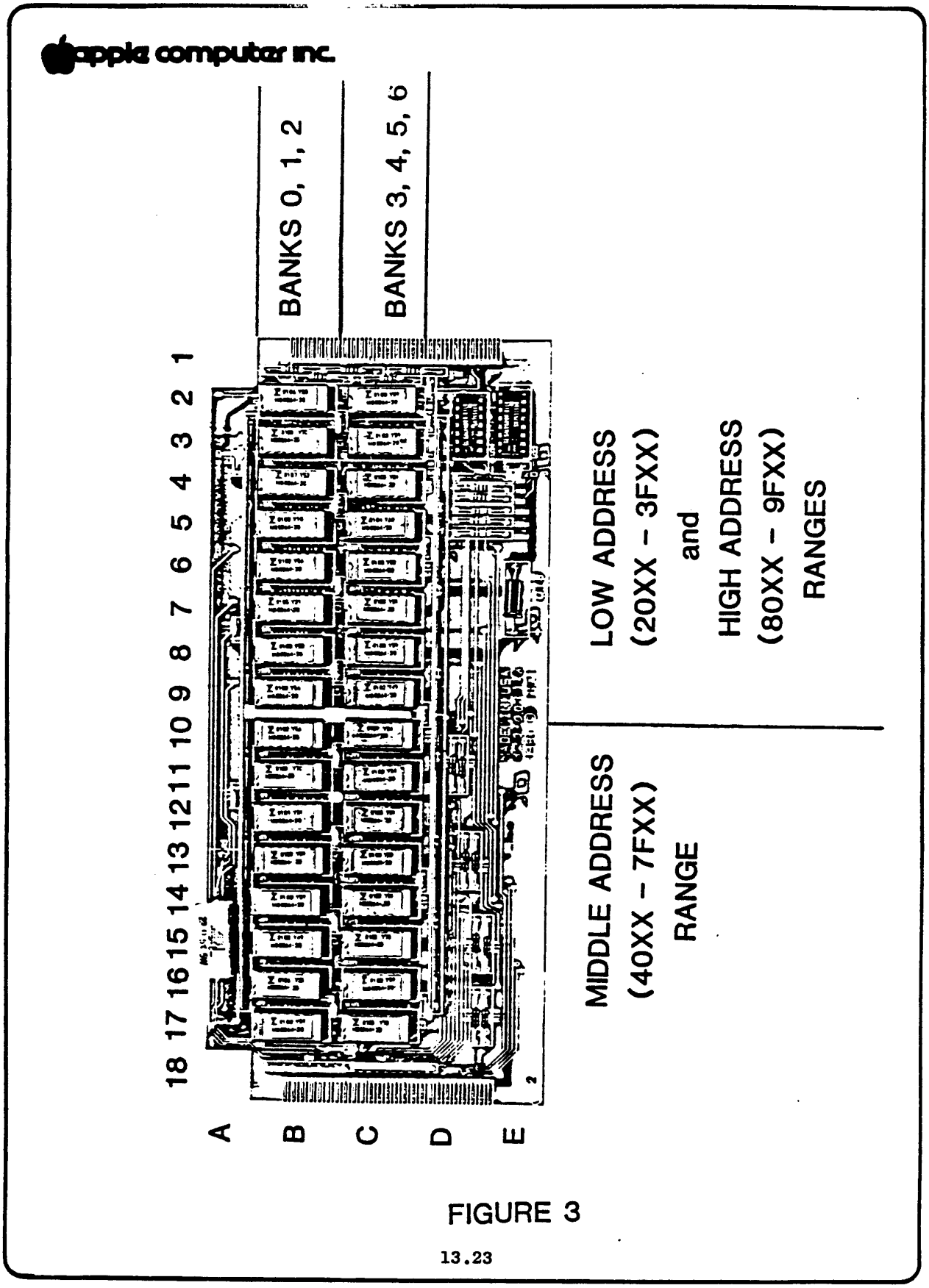

FIGURE 3

13.23

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TRANSLATING MISSING SEGMENTS OF THE MEMORY MAP DISPLAY INTO PHYSICAL RAM LOCATIONS

Sometimes the Memory Test does not give an error message, but instead erases a portion of the memory map display, and continues to test the RAM. Figure 4 below is an example of a memory map display with a missing segment.

1) First, notice the bank(s) that are missing in Figure 4 (listed down the left side). Correlate the bank(s) to the physical row of memory. In our example, banks 3,4,5 and 6 are missing. This means that the failed RAM is somewhere in row C.

2) Determine the address range(s) that are missing (listed across the top.) Translate the address range(s) to the physical section. In our example, address ranges 50XX - 5FXX and 70XX - 7FXX are missing. This falls within the address range 40XX - 7FXX and tells us that the failed RAM is one of the eight which is physically located between C10 - C17 on the memory board.

3) Change the chips in that section, one at a time, retrying the RAM test each time. If the problem still remains, replace the old RAM back in the board and try another of the eight.

4) If you change all eight chips without fixing the problem, try the two non-RAM chips at location D2 and E2 on the 5V Memory Board.

ADDRESS RANGES
(20XX - 9FXX)

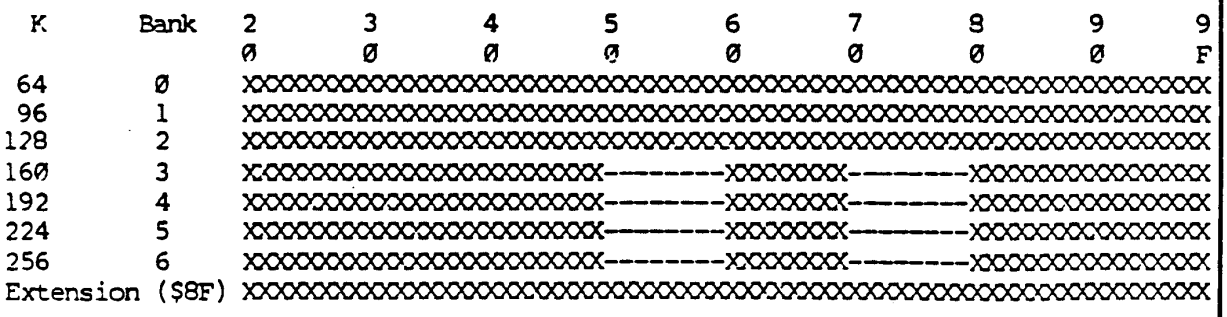

FIGURE 4

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SUMMARY

Translating Error Messages Into Physical RAM Locations

Error Message: BNK 84, ADR 37XX, EXP 40, GOT 48.

1. The physical row is determined by the bank number which is the bank is the last digit of the number in the BNK section. (Bank 4 in our example puts the problem in row C.)

2. Which half of the row is determined by the address range. Our example puts the problem in the right half of the Memory board (Columns 2-9).

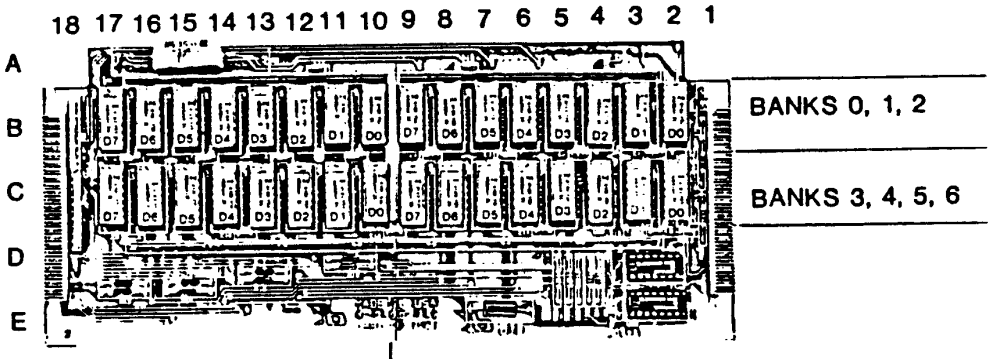
3. The location of the failed RAM chip within the half row is determined by decoding the EXP and GOT messages.

HEX	BINARY	HEX	BINARY	HEX	BINARY	HEX	BINARY
0 =	0000	4 =	0100	8 =	1000	C =	1100
1 =	0001	5 =	0101	9 =	1001	D =	1101
2 =	0010	6 =	0110	A =	1010	E =	1110
3 =	0011	7 =	0111	B =	1011	F =	1111

EXP (40): 4=0100, 0=0000, 40=01000000

GOT (48): 4=0100, 8=1000, 48=01001000

```
     76543210
40:  01000000
48:  01001000
     ========
     ----X---   (D3 is different, so the RAM chip at
                 C5 is bad in our example.)
```



MIDDLE ADDRESS (40XX - 7FXX) RANGE

LOW ADDRESS (20XX - 3FXX) and HIGH ADDRESS (80XX - 9FXX) RANGES

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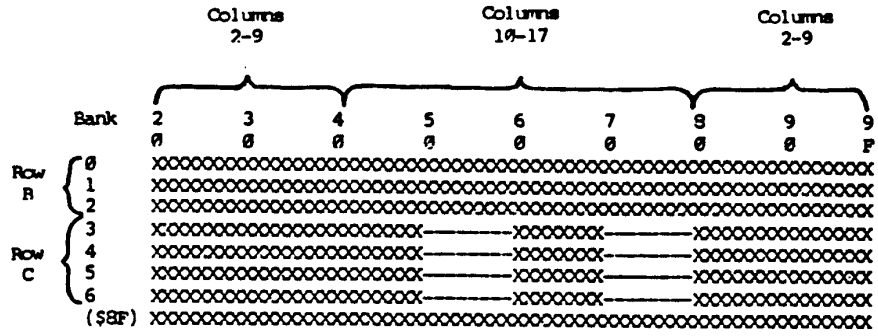
Translating Missing Sections on the Memory Map Display into Physical RAM Locations

1. Determine which row the failed RAM is located from the Memory Map display.

2. Determine the half row the failed RAM is located from the Memory Map display.

3. Replace the eight RAM chips in that half row, one at a time.

4. Replace the non-RAM chips D2 and E2.



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USING THE APPLE /// FLOWCHART

How to use this flow chart:

1) Start with the box at the top of the EXEC page.

2) Perform the action(s) indicated in each block. It's a good idea to take notes on what tests you've done and what the results were.

3) The diamond-shaped blocks are decision points. Many of them contain a test to be made, and a description of a possible result. After doing the test, take the YES exit path if the result you got from the test matches the one given; otherwise take the NO exit path.

Some decision blocks direct your path based on the results of a previous test (usually just before the decision point). Take the YES or NO exit path based on the results of the indicated test.

4) If the system successfully does everything that it should do in the EXEC flowchart, you will be directed to go to the flowchart section appropriate to the problem that you have (**** list here ****). If the system fails, a corrective action may be indicated, or you may be directed to the NO BOOT/NO RESET flowcharts for further tests.

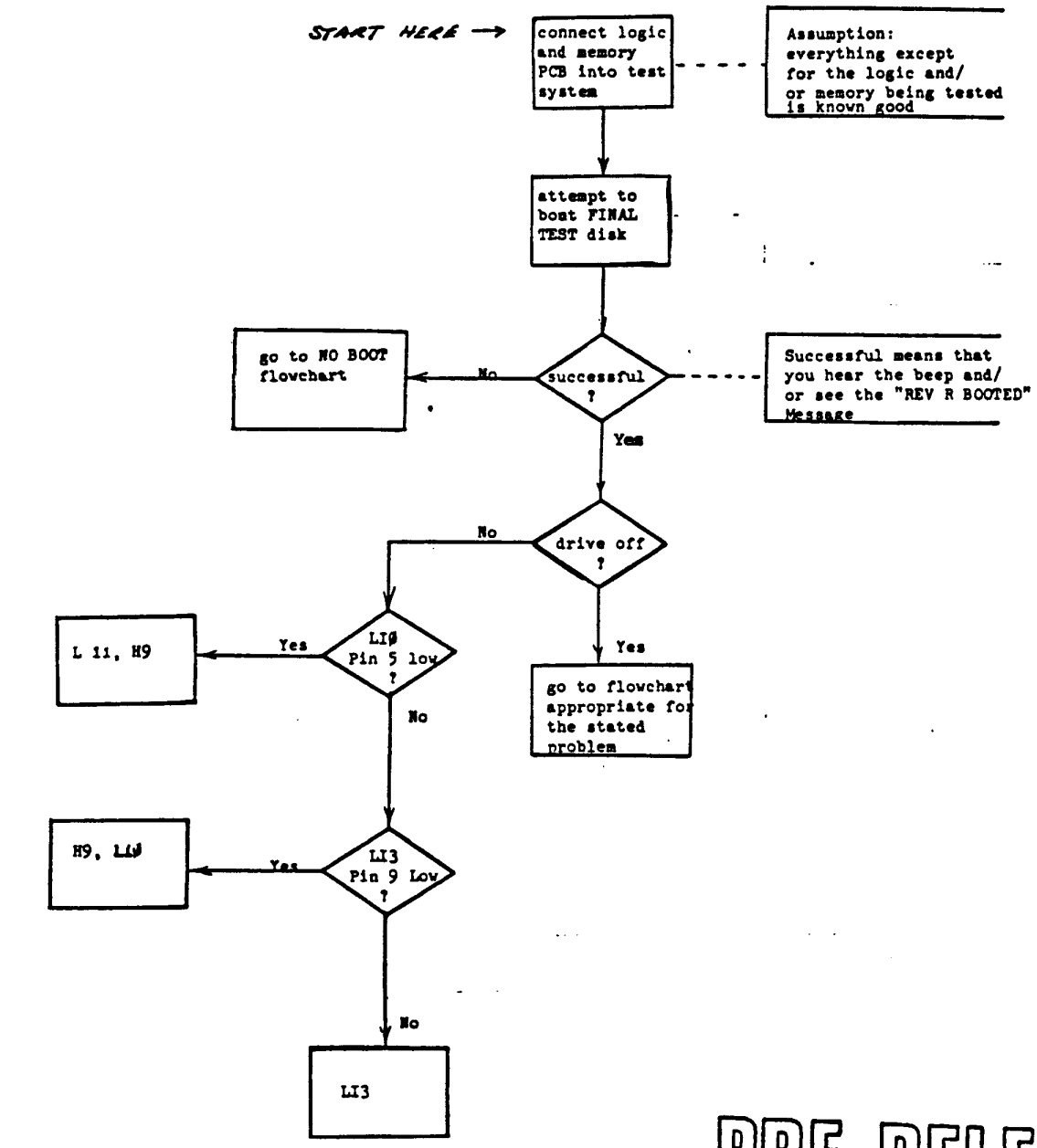
5) Most terminal blocks (ones with no exit) contain a list of motherboard chip locations. Replace the chips at the indicated locations one at a time. After each substitution, test the system to see if the original problem has been fixed. If it is gone, great. If it is still there, try the next chip. If you run out of chips in the list, check the inputs and enables to the listed chips. If you find any that are faulty, trace the fault back towards the source.

Some terminal blocks will contain instructions for corrective action. Do what it says, then test the system.

If you haven't fixed the problem, you have reached a place where the flowchart won't help you (though you should suspect the area of the circuit that it has led you to). Good luck. Once you find the problem, see if you can fix the flowchart so that it will cover that problem. Notify Service Engineering in Cupertino of any errors you find in the flowchart, and of any additions or other suggestions you want to make.

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 1 OF 1
CHART ID _____ CHART NAME A/// FLOWCHART PROGRAM NAME EXEC

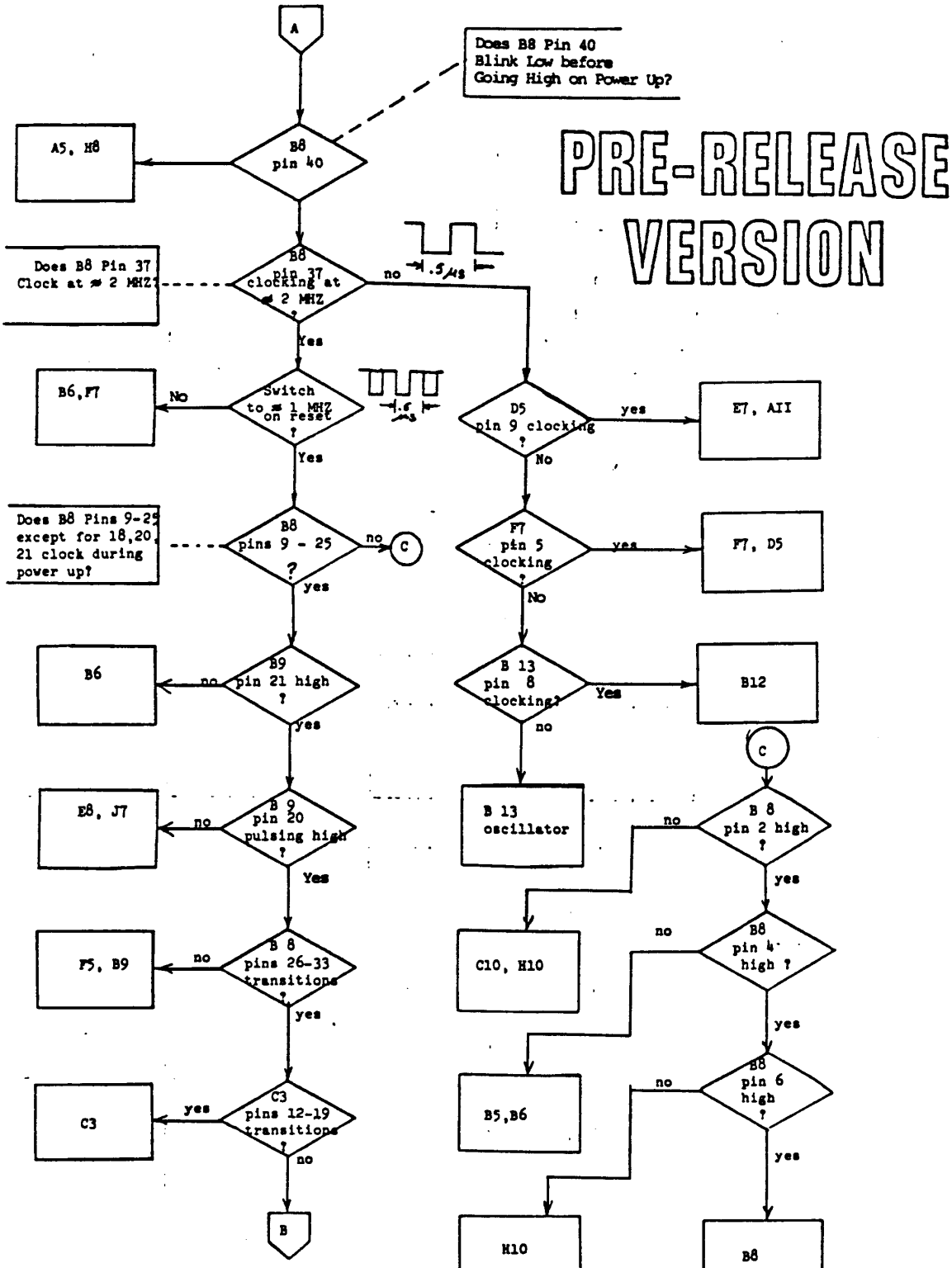


PRE-RELEASE VERSION

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 2 OF 3

CHART ID _____ CHART NAME NO BOOT (NO RESET) PROGRAM NAME _____



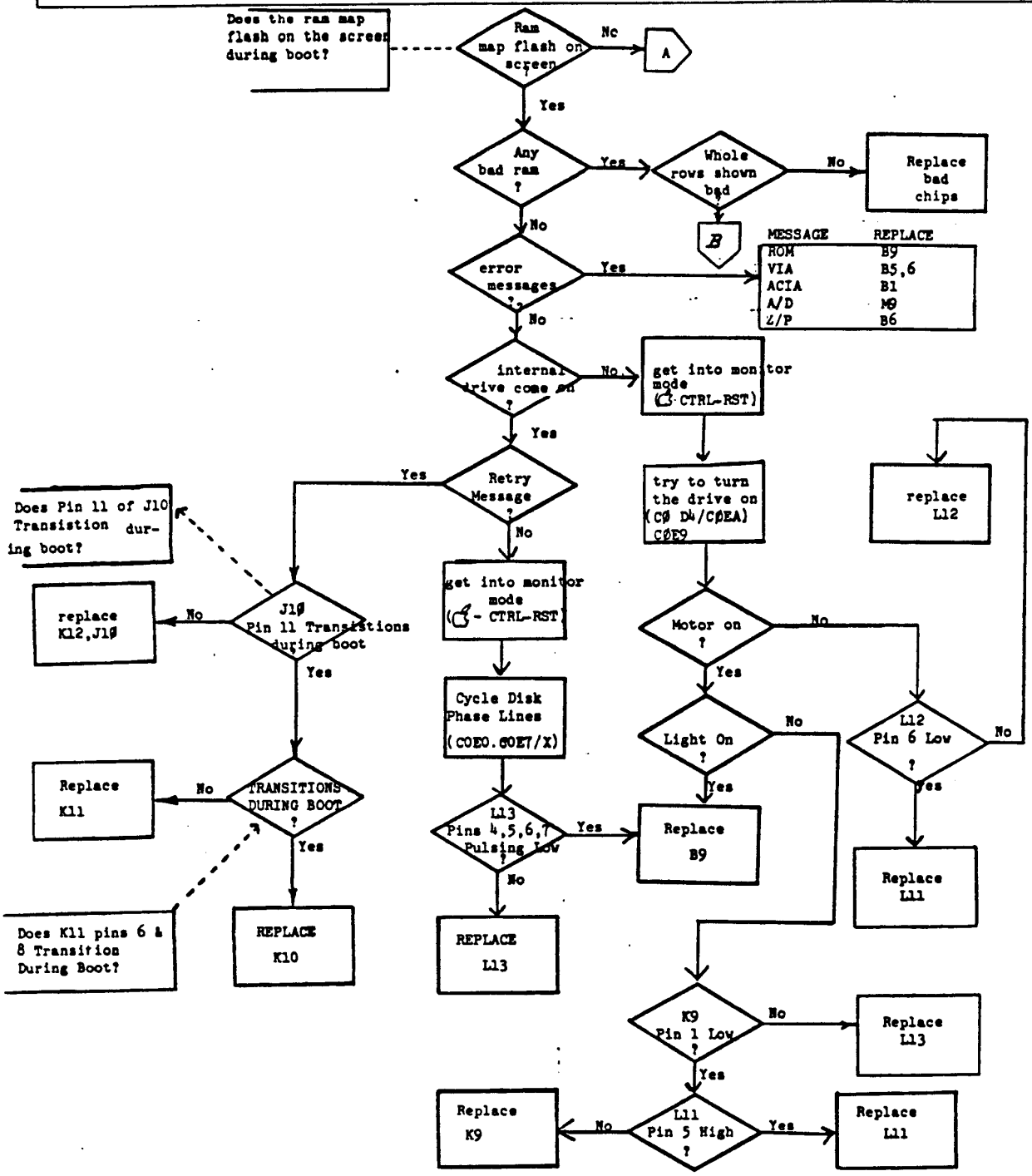
PRE-RELEASE VERSION

13.30

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 1 OF 3

CHART ID _____ CHART NAME NO BOOT _____ PROGRAM NAME _____



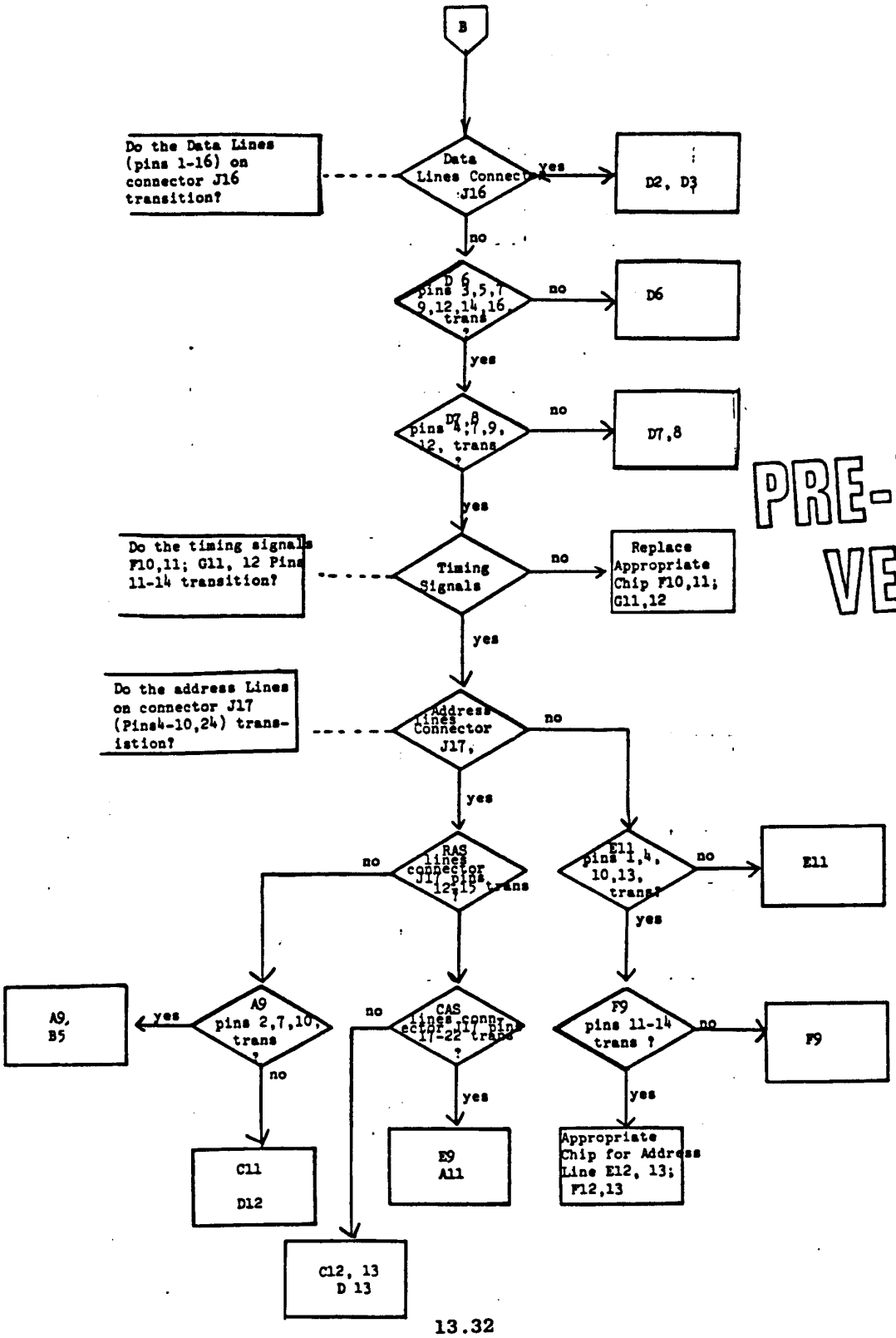
PRE-RELEASE VERSION

13.31

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 3 OF 3

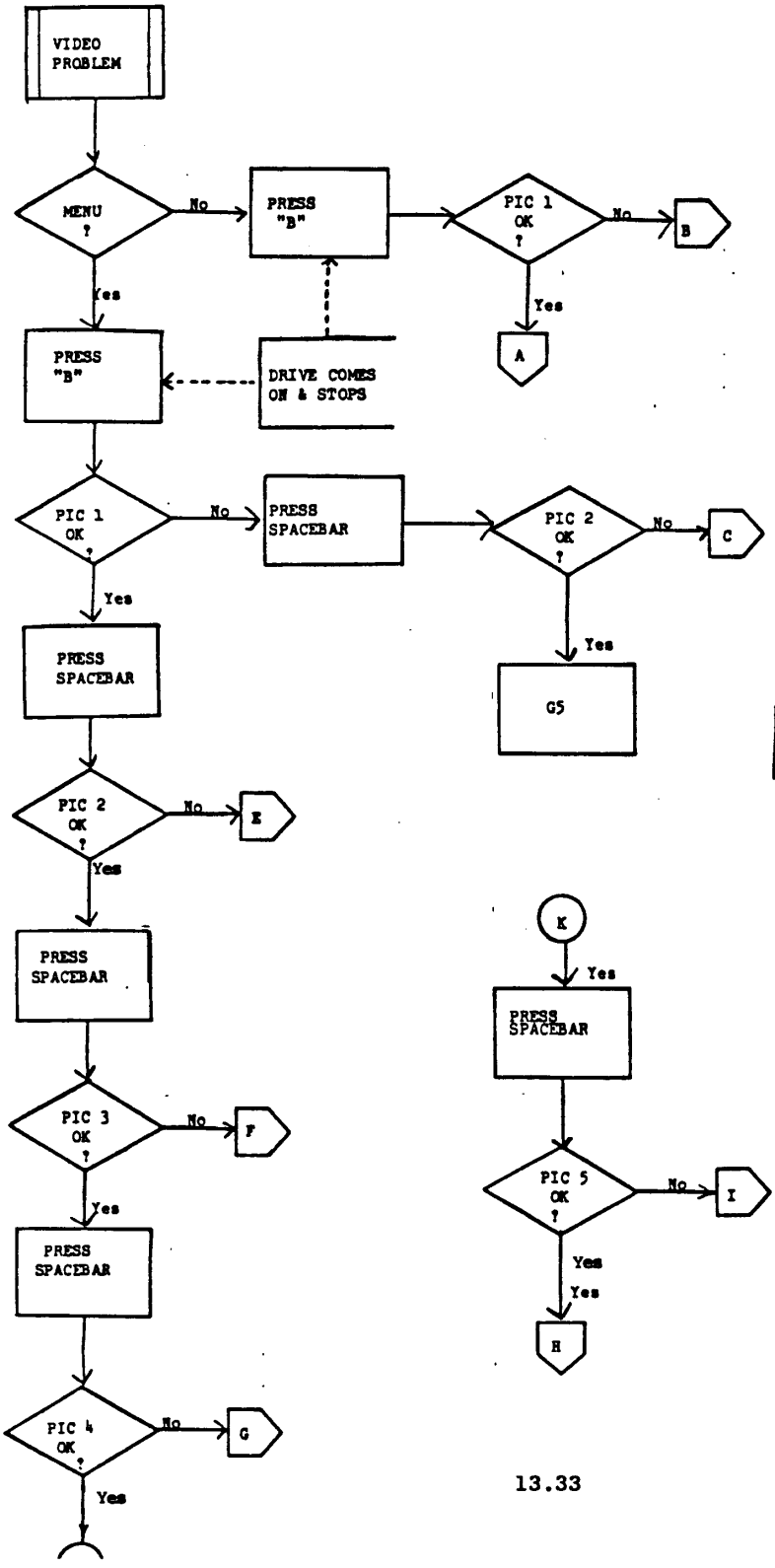
CHART ID _____ CHART NAME NO BOOT (MEMORY) PROGRAM NAME _____



13.32

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE 3/10/82 PAGE 1 OF 6
CHART ID _____ CHART NAME VIDEO PROGRAM NAME _____

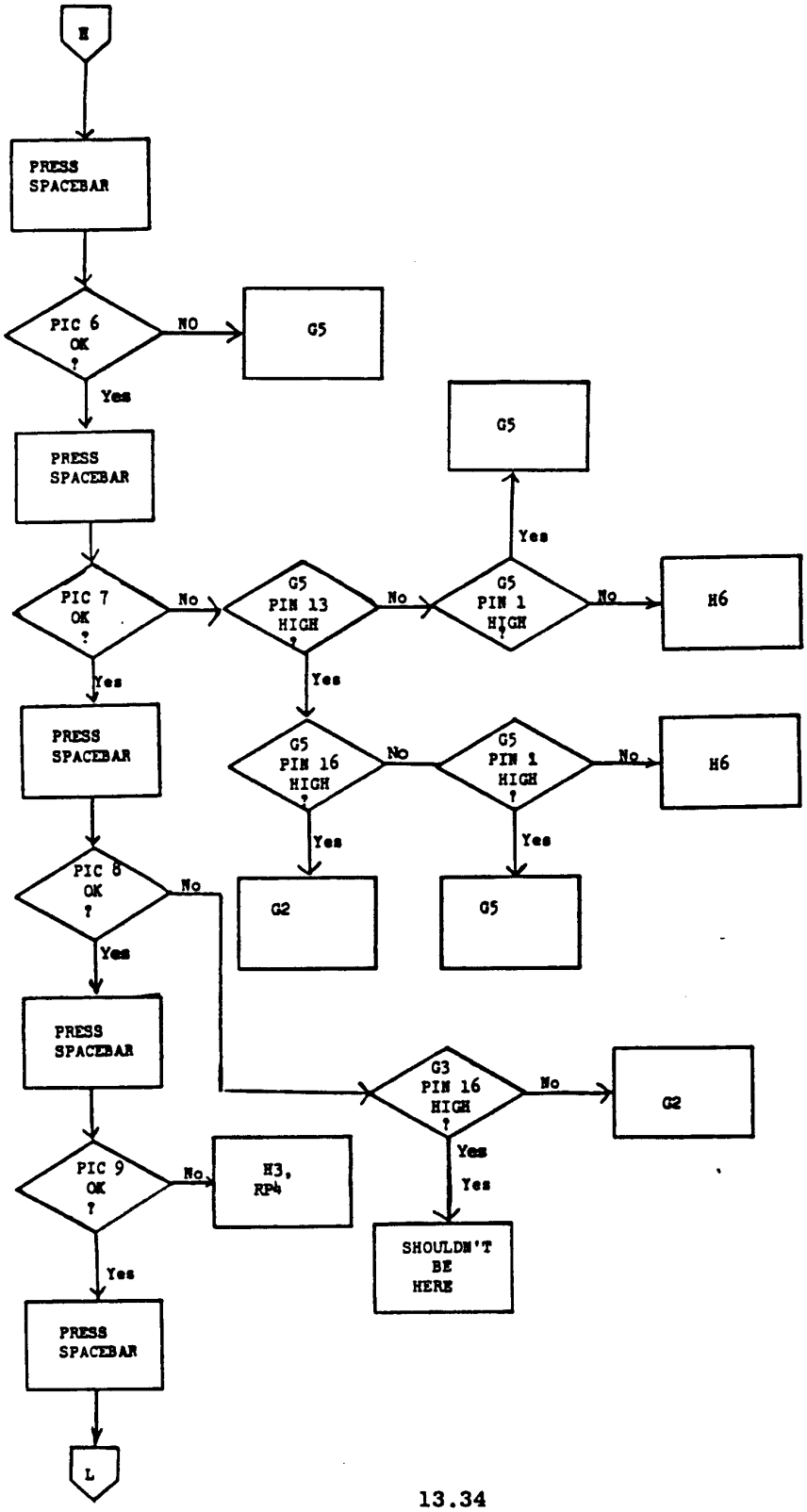


13.33

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE 3/10 PAGE 2 OF 6

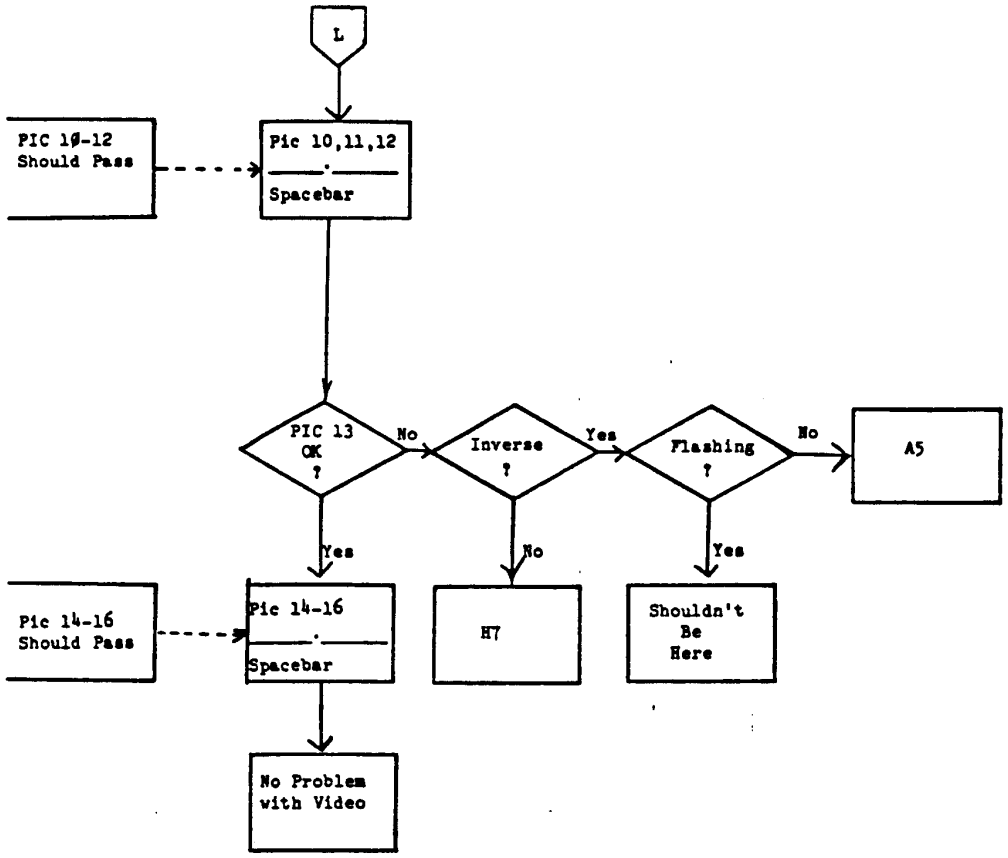
CHART ID _____ CHART NAME VIDEO _____ PROGRAM NAME _____



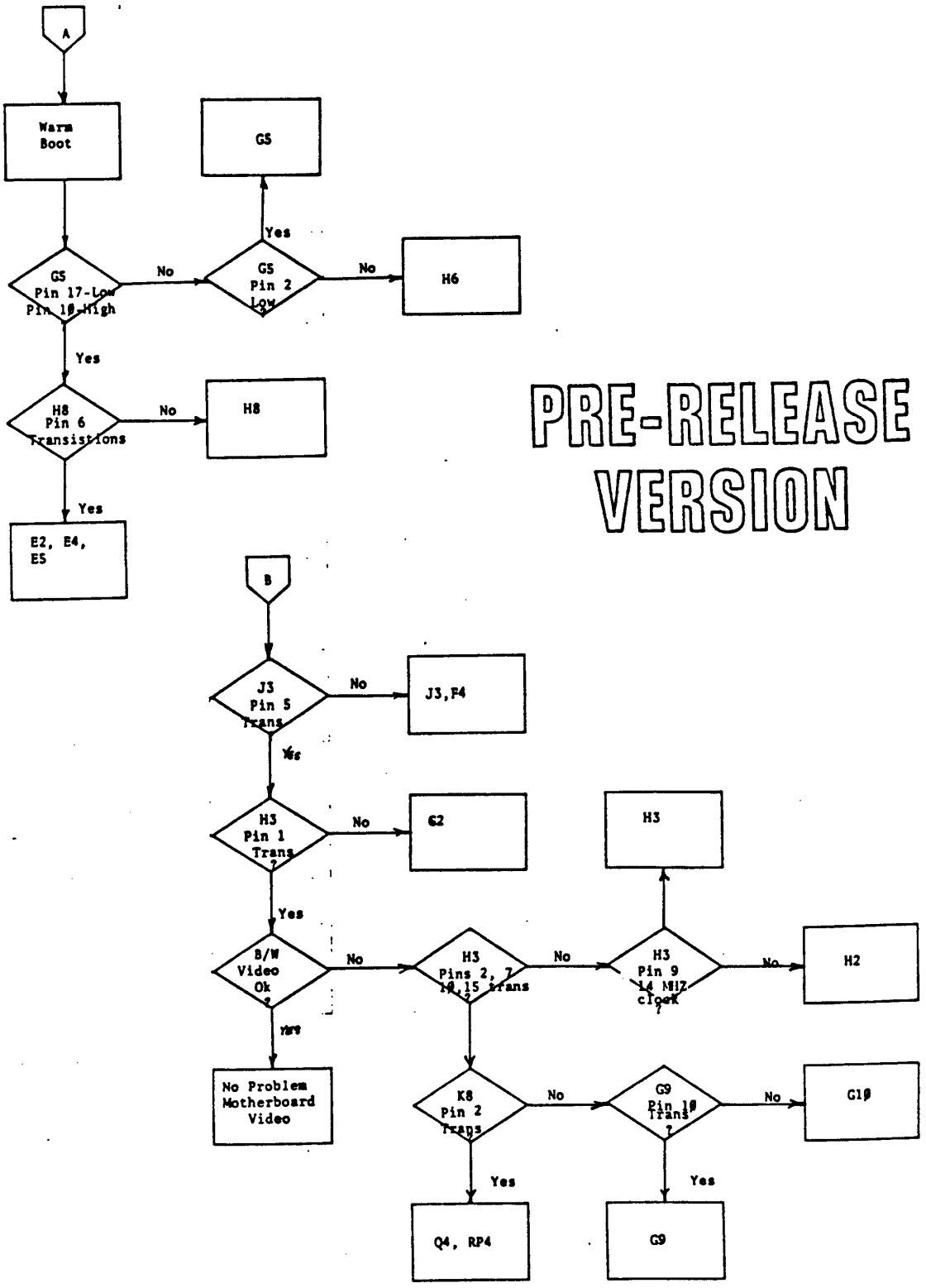
13.34

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE 3/10 PAGE 3 OF 6
CHART ID _____ CHART NAME VIDEO PROGRAM NAME _____



PROGRAMMER _____ PROGRAM NO. _____ DATE 3/10 PAGE 4 OF 6
CHART ID _____ CHART NAME Video PROGRAM NAME _____

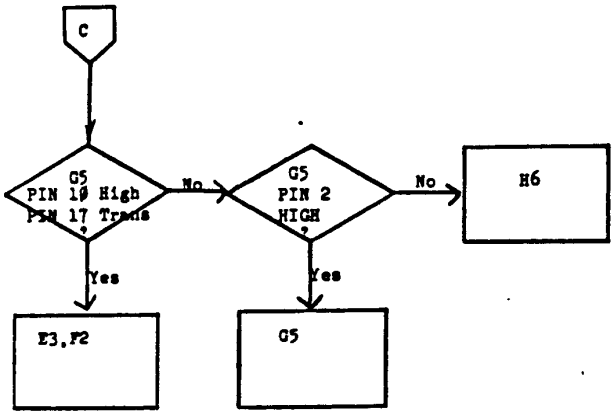


PRE-RELEASE VERSION

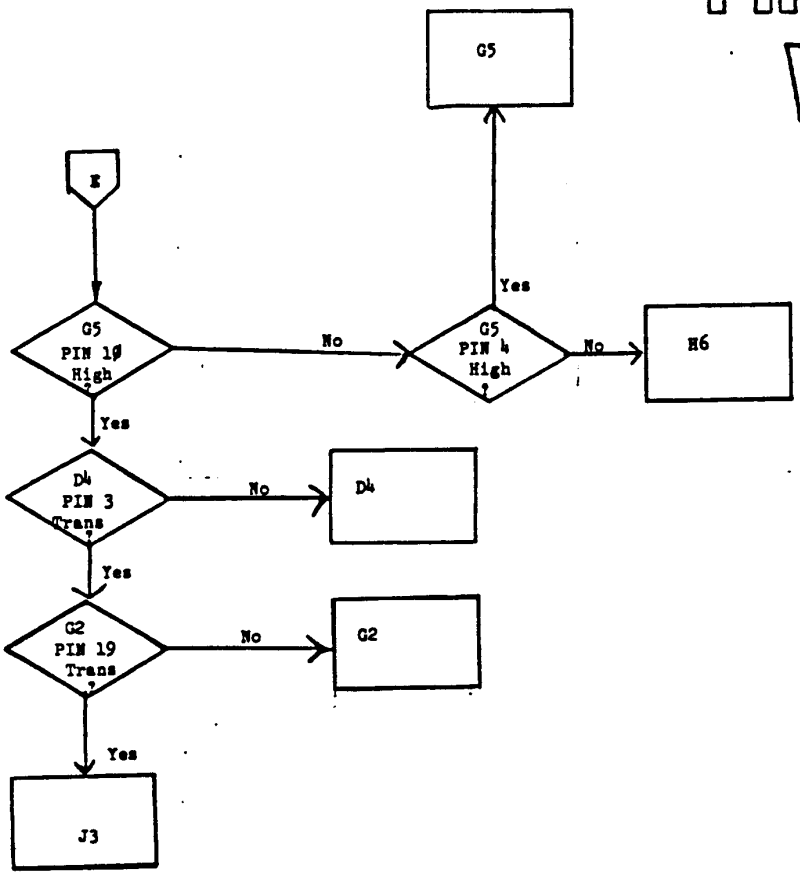
13.36

Flowcharting Worksheet

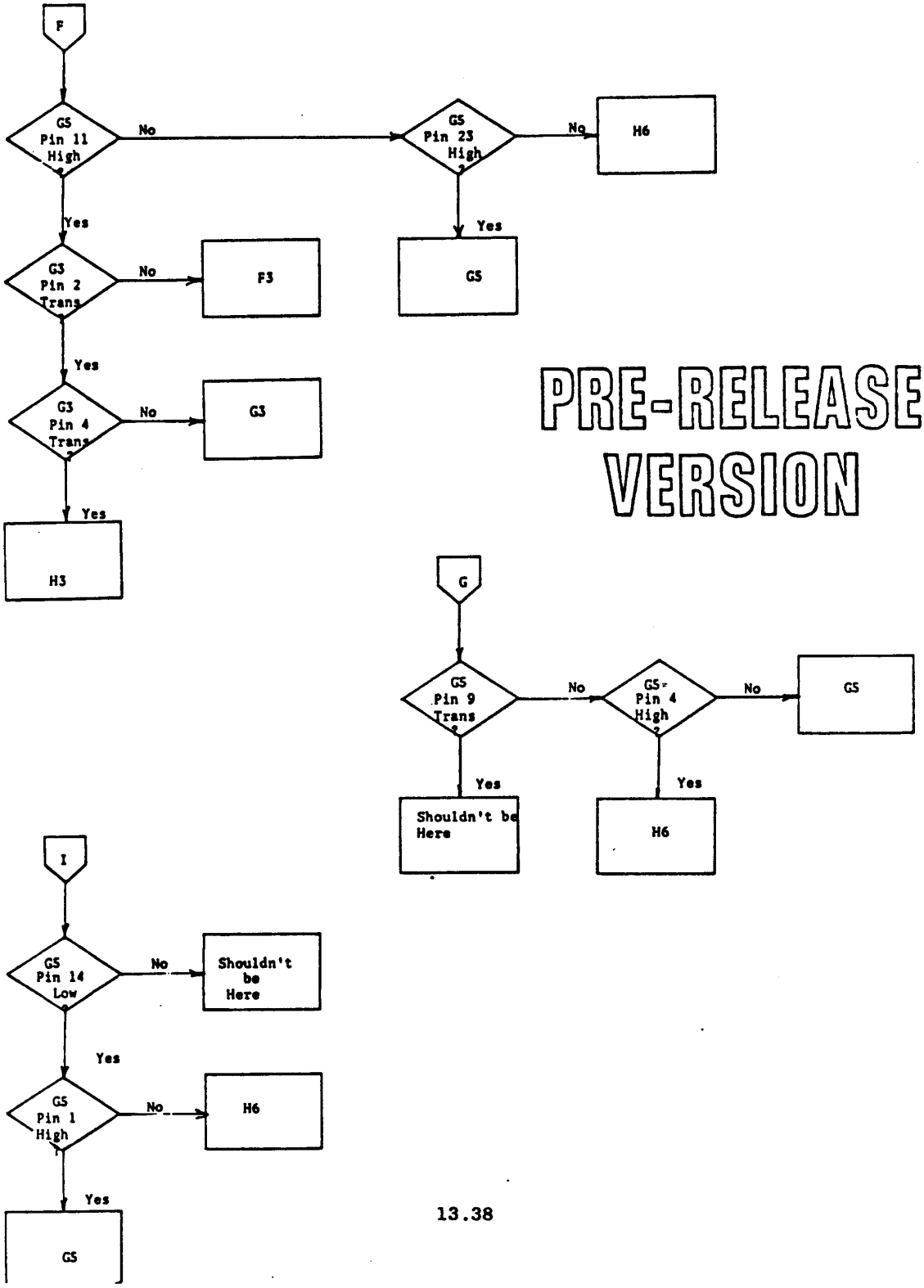
PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 5 OF 6
CHART ID _____ CHART NAME VIDEO _____ PROGRAM NAME _____



PRE-RELEASE VERSION



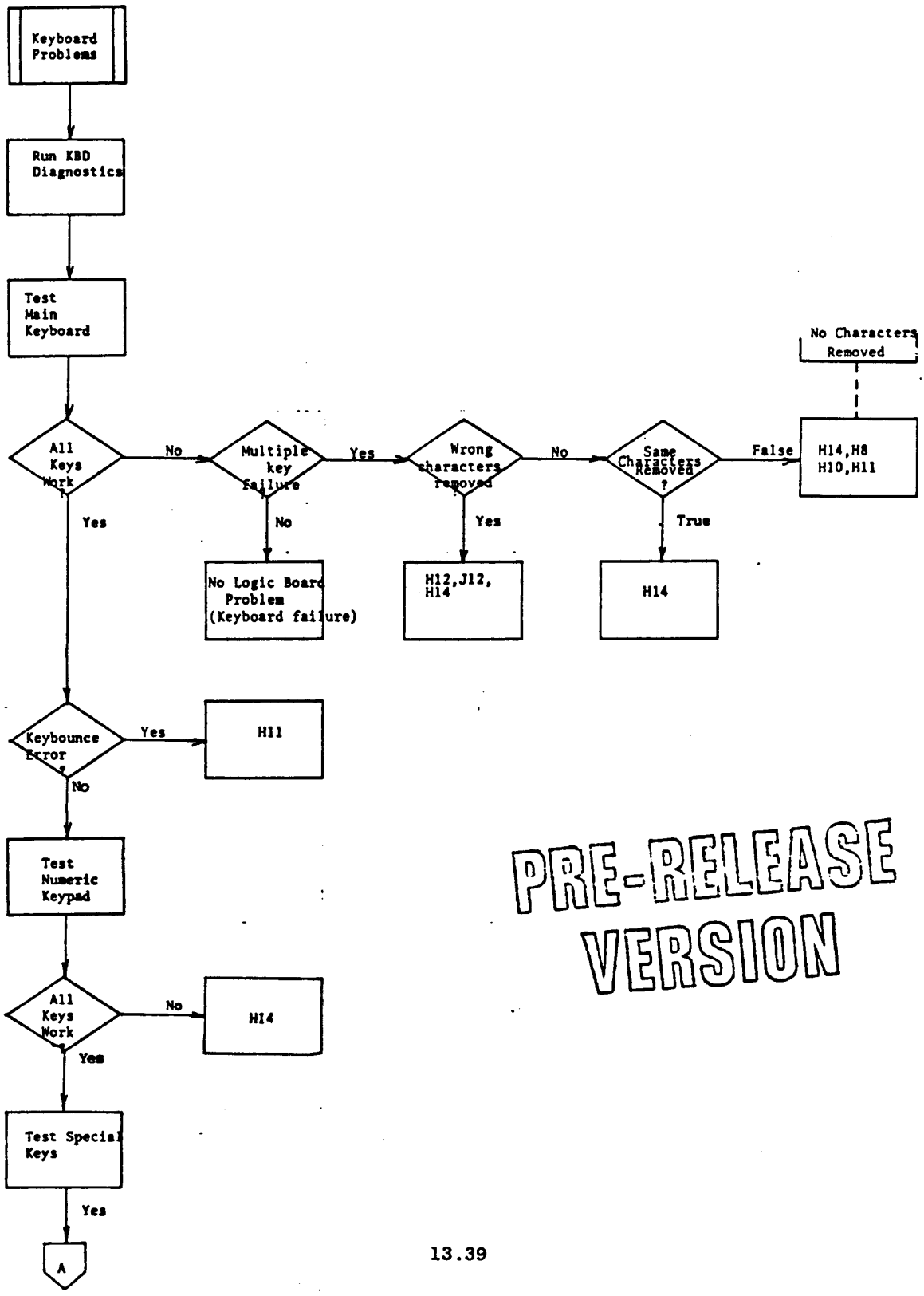
PROGRAMMER _____ PROGRAM NO _____ DATE 3/10 PAGE 6 OF 6
CHART ID _____ CHART NAME Video PROGRAM NAME _____



PRE-RELEASE VERSION

13.38

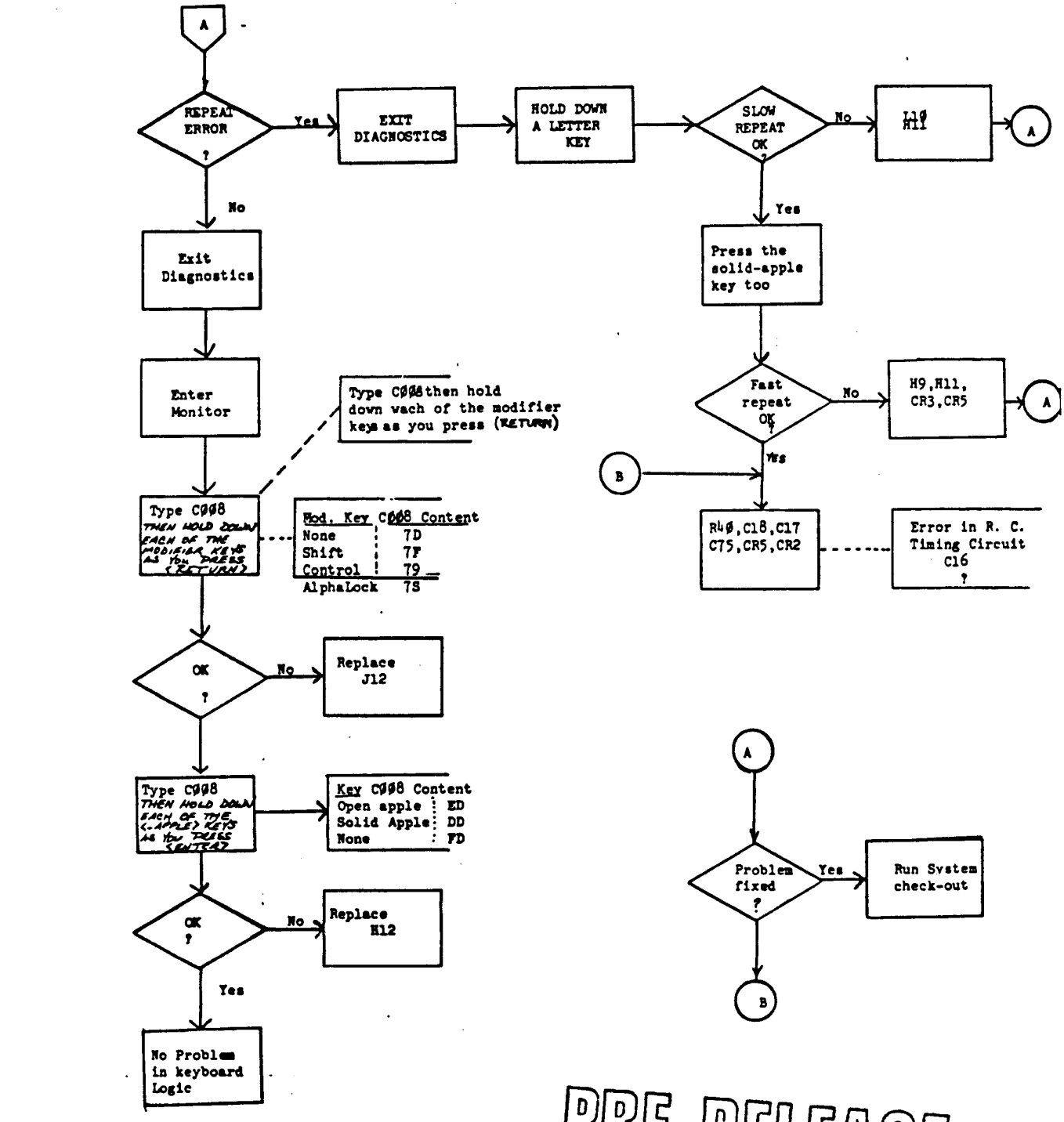
PROGRAMMER _____ PROGRAM NO _____ DATE 3/11/82 PAGE 1 OF 2
CHART ID _____ CHART NAME Keyboard PROGRAM NAME _____



PRE-RELEASE VERSION

13.39

PROGRAMMER _____ PROGRAM NO _____ DATE 3/14/82 PAGE 2 OF 2
CHART ID _____ CHART NAME KEYBOARD PROGRAM NAME _____



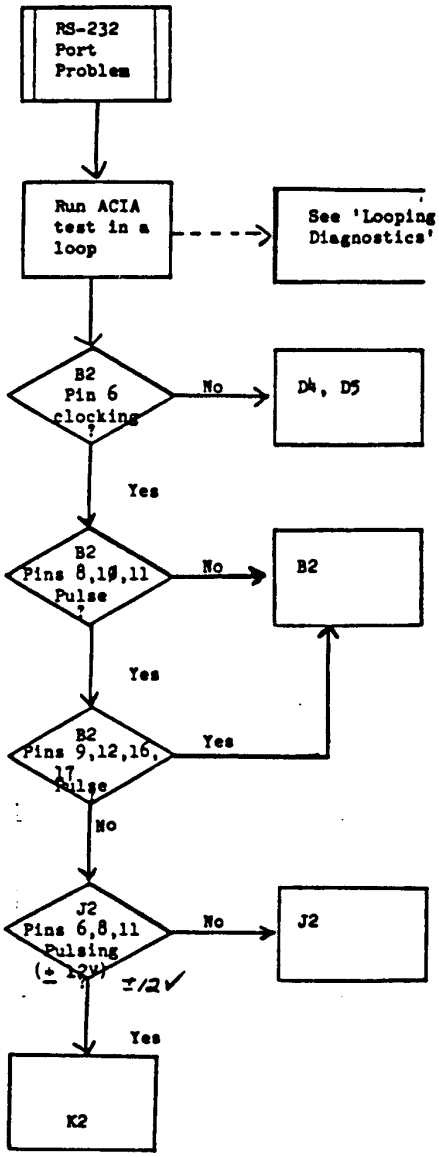
PRE-RELEASE VERSION

13.40

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 1 OF 1

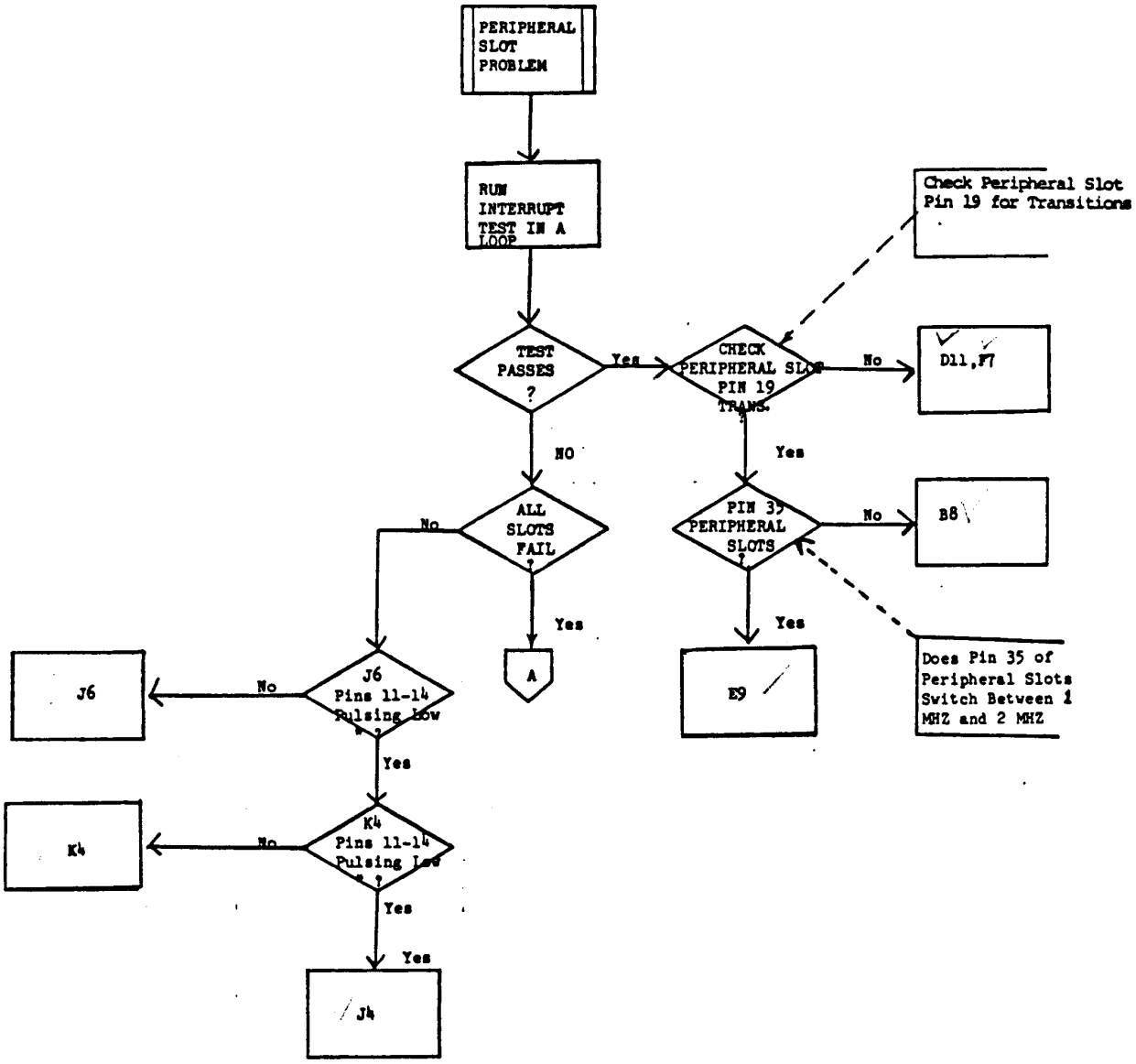
CHART ID _____ CHART NAME RS-232 _____ PROGRAM NAME _____



PRE-RELEASE VERSION

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO. _____ DATE _____ PAGE 1 OF 2
CHART ID _____ CHART NAME PERIPHERAL SLOT PROBLEM PROGRAM NAME _____

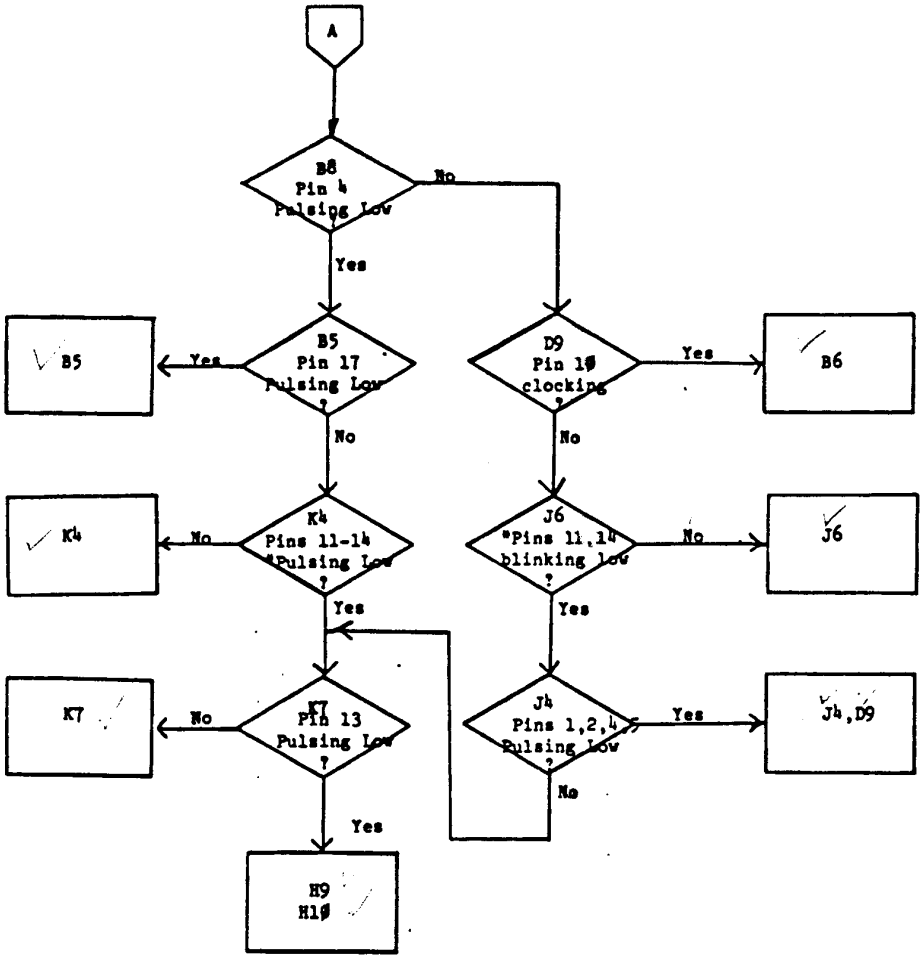


*K4 and J6 Pins 11-14 are very hard to see. If they trigger the scope, they're probably okay.

F5-U176 PROM 1024X4 342-0046

PRE-RELEASE VERSION

PROGRAMMER _____ PROGRAM NO. _____ DATE _____ PAGE 2 OF 2
CHART ID _____ CHART NAME PERIPHERAL SLOT PROBLEM PROGRAM NAME _____



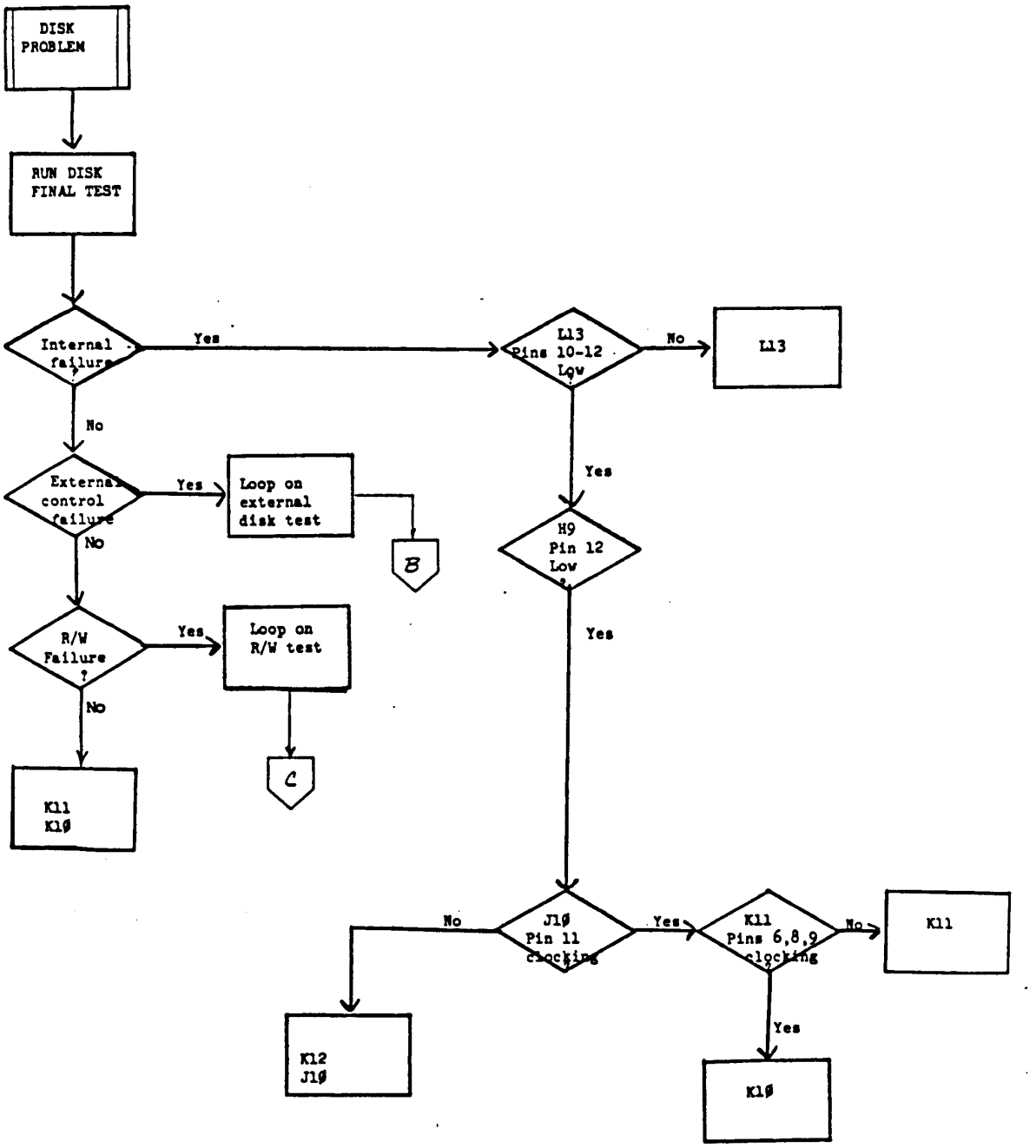
*K4 and J6 pins 11-14 are very hard to see. If they trigger the scope, they're probably okay.

PRE-RELEASE VERSION

13.43

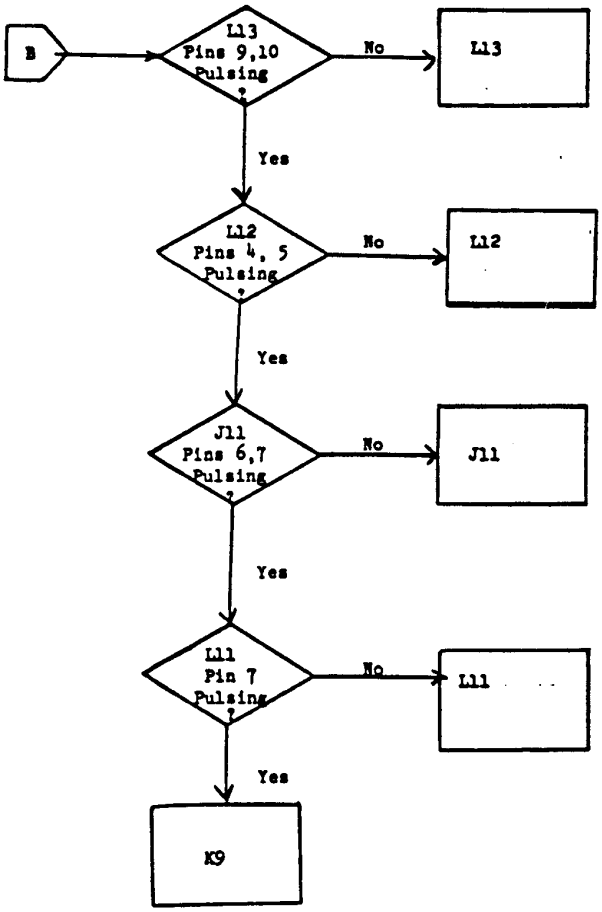
Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE 3/15 PAGE 1 OF 3
CHART ID _____ CHART NAME DISK PROGRAM NAME _____



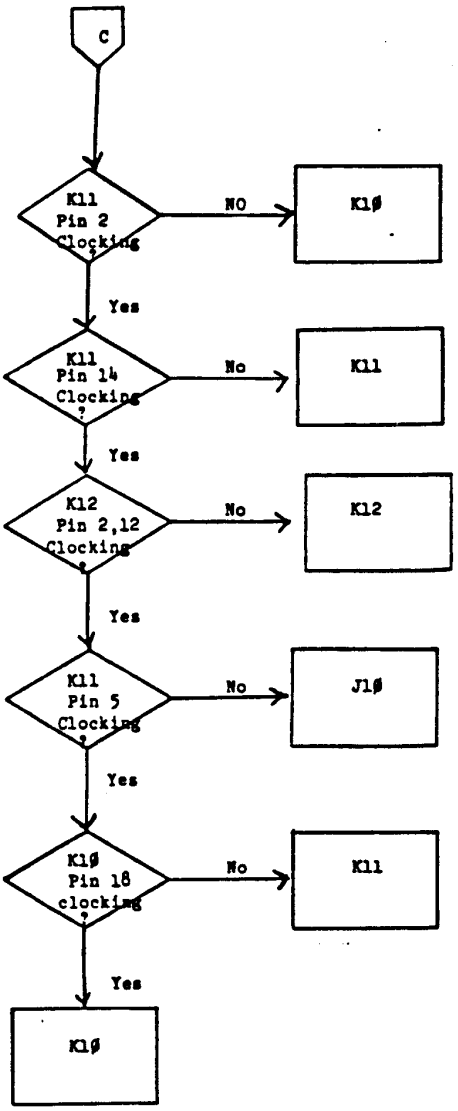
Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE 3/15 PAGE 2 OF 3
CHART ID _____ CHART NAME _____ DISK _____ PROGRAM NAME _____



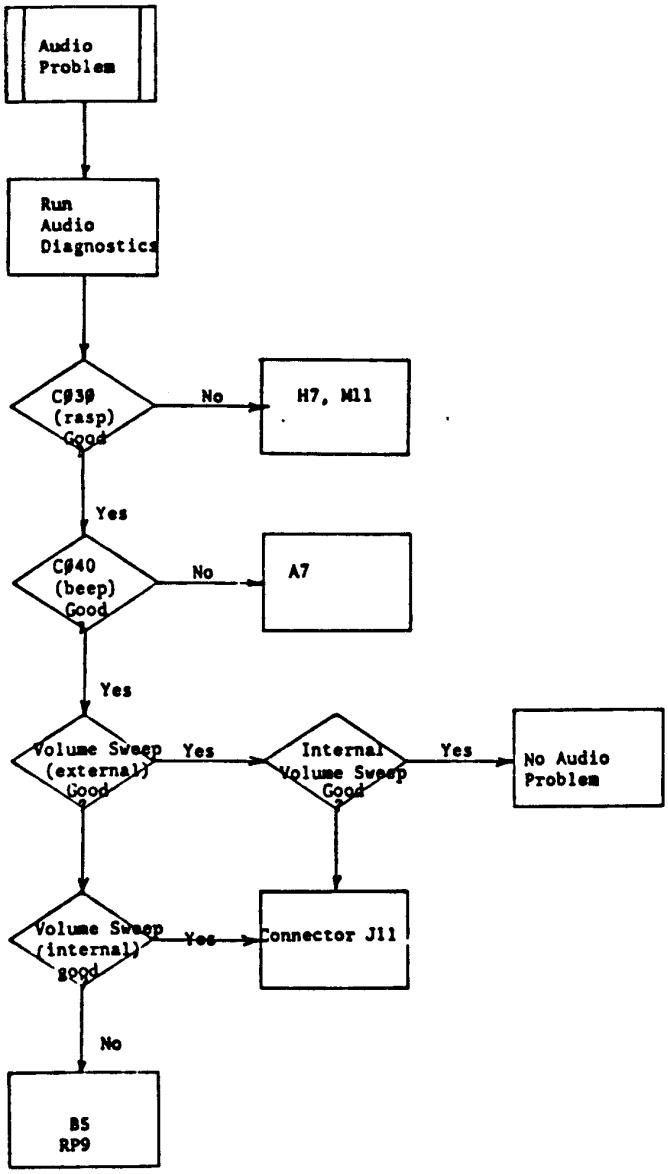
Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 3 OF 3
CHART ID _____ CHART NAME DISK _____ PROGRAM NAME _____



Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO. _____ - _____ DATE _____ PAGE 1 OF 1
CHART ID _____ CHART NAME SOUND PROGRAM NAME _____

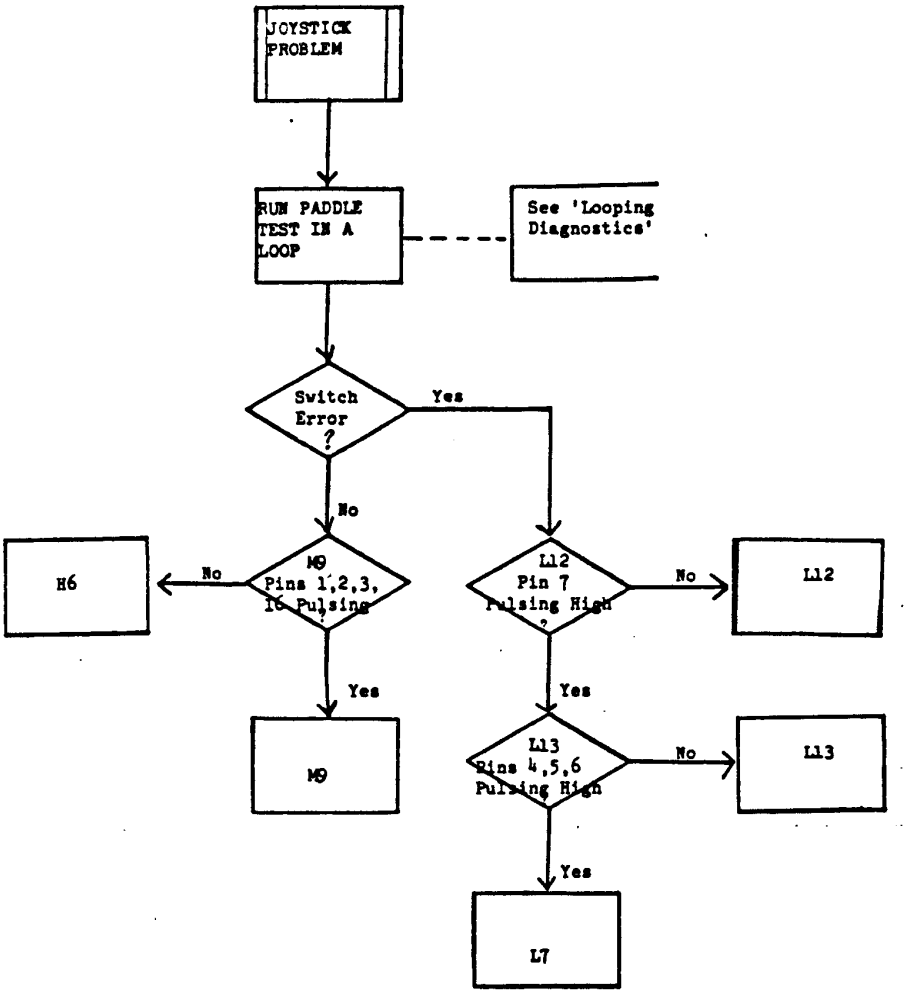


PRE-RELEASE VERSION

Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 1 OF 1

CHART ID _____ CHART [illegible] JOYSTICK PROGRAM NAME _____

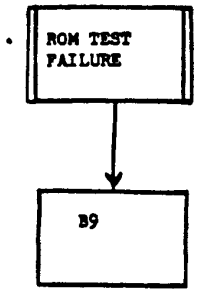


PRE-RELEASE VERSION

Flowcharting Worksheet

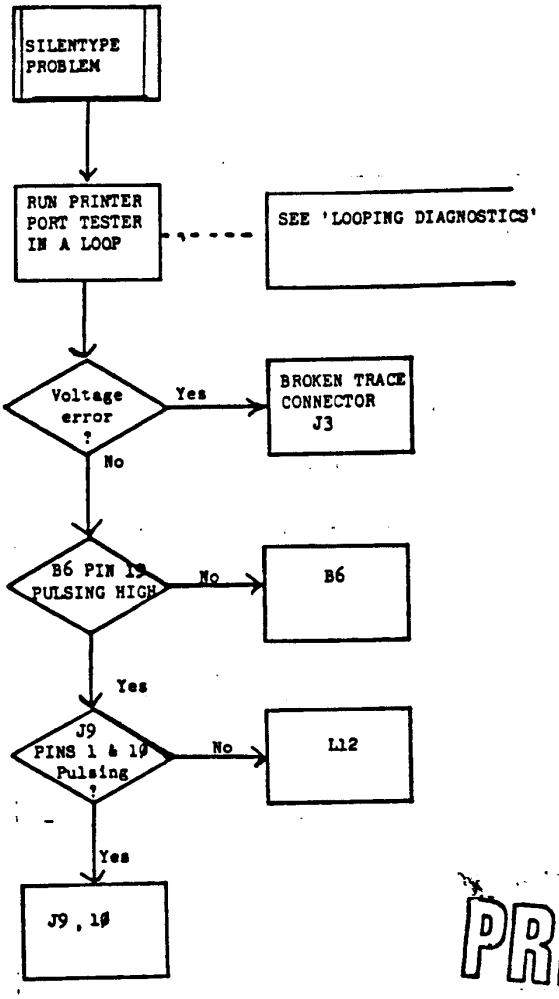
PROGRAMMER _____ PROGRAM NO _____ DATE _____ PAGE 1 OF 1

CHART ID _____ CHART NAME ROM PROGRAM NAME _____



Flowcharting Worksheet

PROGRAMMER _____ PROGRAM NO. _____ DATE _____ PAGE 1 OF 1
CHART ID _____ CHART NAME Silentype PROGRAM NAME _____



PRE-RELEASE VERSION

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FAULT ISOLATION - TIPS AND HINTS

The following pieces of information are by no means an absolute guarantee of success in isolating a failure mode. This is intended only as a GUIDE or AID to assist you in finding a logical and likely place to begin your troubleshooting of the particular failure mode.

F6E6 TEST (12V MAIN LOGICS)

RAM indicates a memory failure. Use the chart included below to determine which chip on the moemory board is failing. Other possibilities are the memory board connectors. If is is an addressing problem, check J17, (the connector on the right) and if it is a data problem, check J16, (the connector on the left).

RAM FAILURE CHART 128K SYSTEM DISPLAY

DIAGNOSTIC RAM

```
........
........
........
........
........
........
........
........
```

A 1 showing any place that a dot is shown here indicates a failure. The position of the one shows which chip has failed. The chart below shows the chip location on the memory board.

```
B9  B8  B7  B6  B5  B4  B3  B2
B17 B16 B15 B14 B13 B12 B11 B10
B9  B8  B7  B6  B5  B4  B3  B2
B17 B16 B15 C14 B13 B12 B11 B10
C17 C16 C15 C14 C13 C12 C11 C10
D9  D8  D7  D6  D5  D4  D3  D2
D17 D16 D15 D14 D13 D12 D11 D10
C9  C8  C7  C6  C5  C4  C3  C2
```

ROM indicates that the ROM failed. Check the ROM at B9 (341-0031-01). Usually the ROM itsely is bad when this message appears.

VIA indicates that a register in one of the 6522's has failed. These two parts are the 40-pin IC's at location B6 and B5.

ACIA indicates that the 6551 located at B1 has failed. A/D ia an indicator of a bad read of either the high or lw reference voltage of the 9708 chip located at M9.

ZP indicates a zero page register failure. The zero page register is port B of

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the 6522 located at B6. Other possible chips for this failure are the S257s at locations D7 and D8 or the Ls132 at D4. This is where the zero page portion of the address gets fed to the system memory. Also note the NOT ZPAGE signal which should originate at the LS51 at B11.

RETRY is a message the system gives when it is unable to "boot" the disk that is (or should be) in the internal disk drive.

OTHER FAILURE MODES:

These are usually idetified when running the normal system test diskette.

NO RESET is probably the most difficult porblem to fix and the easiest to identify. It's main symptom is that when power is truned on, absoultely NOTHING happens. The disk does not even ATTEMPT to boot and there are no beeps. Keep in mind that SIGNATURE ANALYSIS is a very good way to find a NO RESET problem. Below are some of the things that you can check fairly quickly:

Is the keyboard light lit and is the LED on the PC boared lit. It not make sure all power is available. +5VDC, -5VDC, +12VDC, & -12VDC.

Make sure that +5VDC and ground is available at each row. (Especially rows B, D, F, & G).

Check the levels at the RESET, NMI, IRQ, and RDY pins of the CPU at B7.

Swap the ROM (B9) with a known good ROM. If there is no difference replace the original.

Swap the CPU (B7) with a known good CPU. If there is no difference replace the original.

NOTE: These last two items are the most common reasons for NO RESET.

Power OFF and check for shorts on the Address or Data Bus.

Make sure that all clocks are runing. Phase 0, PRE1M, 14M, 3.5M, and 7M.

Other devices that are frequently causes of NO RESET are listed below:

LOCATION	DEVICE	COMMENTS
Row F & C	7643	high failure items
Row B	6522	B6 is more likely
C3	8304	high failure items
Row E & F	74S153	high failure items
A5	NE556	and supporting circuitry
D13	74S374	high failure items
D6	74LS244	high failure items
D3 & D7	74S257	Not very often
K9	74LS04	not very often
D9	74LS02	moderate failure item
D11	74S74	Make sure its not LS

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G7 & J7	74LS133	high failure items
G8	74LS139	high failure items
H8	74LS04	high failure item
J8	74LS32	moderate failure item

For a RAM addressing problem check the memory board connector on the right side, (J17), and for a RAM data problem check the memory board connector on the left, (J16). NOTE: A RAM data problem will USUALLY run the F6E6 test.

Miscellaneous reset problems have been caused by the following:
diode CR4 .....reversed, open or missing
RP19 (S19).....3.3K shorted
Xtal.....not oscillating
reset key.....bad
power or ground.....missing due to open pin/trace

It may also help you to know that there is an 85% chance of the problem being found on sheets 2 and 3 of the Apple /// schematic, and a 13% chance of being found on sheets 9 and 4. Good luck on the other 2%.

NO BOOT is recognized by the fact that the system actualy ATTEMPTING to boot even though it doesn't succeed. Video may or may not be present. You may see the RETRY message, and the disk may run itself off, or it may stay on. Some of the more common things to check are:

The 9334's at L12 and L13.
The 74LS04 at K9.
The mostly likely choices are:

device	location
74LS323	K10
74S471	K11 (P6A prom)
74LS174	K12

Concentrate your troubleshooting efforts on sheet 6 of the Apple /// schematic, unless you find a problem with the NOT devsel-6, or the NOT Q3 signals. Any other problem external to sheet 6 would most likely also show up in a RAM test, or video test.

VIDEO problems can be very simple at times and downright troublesome at other times. Some of the mose common failures are:

By far, the most likely candidates, are the 74LS374's, located at E2, E3, F2, F3, G2, & G10. These IC's are the cause of >70% of the video problems.

It is also a good idea to check the two 2114's located at E4 and E5.

The next most frequent failure is the 74LS153 at L8. This is U90 as shown on sheet 5 of the schematic.

Video problems are also very likely to be misdiagnosed timing problems. For these check the 64S195 at D10 and the 74LS374 at D11.

If the video horizontal or vertical sync appears to be messed up, check the 74LS161's located at F10, F11, G11, and G12.

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If none of the above items point you toward the real problem, begin your troubleshooting on sheet 5 of the schematic where 80% of the problems occur, and if necessary, go on to sheet 9, where most of the remaining video problems will be found.

Keep in mind that an off-frequently crystal can kill the color or produce bad color.

INTERRUPT problems almost always end up being one of the VIA's (or 6522's). However, there have been a few other reasons for interrupt failures as described below:
I/O NMI is a symptom for sheet 8 of the schematic. Check the 74LS132 at H10 and the 74LS139 at J11.
IRQ signal missing can be caused by the 74LS21 at J4.
Sometimes the problem is noit actually an interrupt problem but the systems inability to communicate with the interrupt test cards. In the case of a missing IO SELECT, check the 74LS138 at J6, and in the case of a missing DEVICE SELECT, check the 74LS138 at K4.
Remember to check the connectors at the slots for continuity to the 74LS138's mentioned above.
Lastly, here's what happens during the INTERRUPT test:

Step 1 Disable all interrupts, mask NMI, enable I.O space, reset ACIA, re set all four slots, and set up the 6522's as they are normally used.
Step 2 Check both 6522 int enable register bits 0-6 to see if they can be set and cleared.
Step 3 Vertify that IRQ and IONMI are clear as they should be.
Step 4 Clear both 6522 interrupt flag registers and vertify that they are indeed clear.
Step 5 Check the 6522 interrupt flags to see if they can be set and cleared when enabled and vertify that they cannot be set when disabled.
Step 6 Repeat once for each slot.
- a. Set slot IRQ by using IO SELECT and vertify by polling slot.
- b. Clear slot IRQ using C02X and vertify by polling slot.
- c. Vertify that the 6522 at B6 caught the IRQ and that it was the correct one and that it can be cleared.
- d. Set slot IONMI using DEVICE SELECT and vertify by polling IONMI.
- e. Clear slot IONMI using C02X and vertify by polling IONMI.

Step 7 Check for shorts between slot IRQ's by setting IRQ on one slot at a time and checking each IRQ on the other slots.

AUDIO troubles are usualy fairly simple to repair. The most common ailments are listed below:
The most common frequent failure is the LM380 which is located at M11, and rarely you may find a problem in its associated circuitry, notably R36, a 1K resistor and C12, a 10uf cap.
The second most frequent, usually noted on the C040 portion of the test, is the 556 located at A7.
Another common ailment is J11, the external speaker jack which is the mini-phone jack at N4. Note that a bad contact in this jack can also prevent you from hearing any internal sound.
Failure of the C030 test can be caused by the 74LS74 at H7.
And last, a failure of the FFE0 test can be caused by either the 6522 at

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B5, or RP9 the SIP located at C5.

ACIA problems are also usually fairly simple and usually end up being caused by only a few items:
The most common failure is, of course, the 6551 itself. This is located at B2.
The next items to check, will be the 1488 at J2 and the 1489 at K2.
The third most common failure is J4, the 25 pin D connector at N2.
The less likely things to check, are, the SEL6551 from the 74LS138 at K4-7, and the RC network (or R-pak) at N3.

PADDLE PORT problems frequently coincide with printer port problems. This is because they both share the DB-9 connector N10, (J3). Some causes of paddle port problems are:
The 9708 located at M9. This is the most common cause of failures.
The second most frequent cause of failures is the RC network at N10.
Other things to check that can sometimes cause problems, are the 9334's at locations H6, L12, and L13. These IC's supply some fo the enable neccessary during the paddle port tet, including the disk pahses, and disk side 2/1 signals used to test the switches, as well as the ENSIO and ENSEL signals.
Also check the enables coming from the 74LS138's at K4 and K7.
Finally check the 74Ls251 at L7 and its enables.

RAM FAILURES can be almost as much fun as no reset can be. Some of the things to look for are:
Of course, the most obvious thing to check is the F6E6 test results and see which row, group, chip(s) are causing problems. Also check the two memory board connectors J16 and J17 at this time.
You have about 98% chance of the problem being on sheet 2 of the schematic. With the highest probability, being the 74LS399 at A9 and the 74S3 74S374 at D13.
Next check the 7643's at locations C10, C11, C12, and C13, and then check the 74S153's at E12, E13, F12, and F13.
It may be a little help to do the following IF and ONLY IF you can get into the monitor routines using a CONTROL-APPLE-RESET:

a. Type the following:
   FFDO: 0/FFDF:IF/FFEF:0 (RETURN)
   You have just set the bank register and zero page to 0 and disabled the screen and IO addresses. (Note that FFEF if the bank register and you may want to try settings other than 0 if this setup doesn't find your problem.
b. Now type:
   0.FFFF/X (RETURN)
   The address bus should now be one big 16-bit counter and therefore easier to trace with an oscilloscope.

PRINTER PORT failures will show up as paddle port failures most of the time. The few exceptions are, that some of the polarities of the enables are reversed, causing the signal direction to also be reversed. (For example, a paddle port INPUT becomes a printer port OUTPUT). Also, be sure to check the connections to slot 1 to insure that the test hardware will function properly. The best way to check this, is to check for continuity from slot 1 to slot 4, (except for pins 1, 30, and 41).

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DISK failures will usually prevent the system from booting properly. There are, however, a few things which should be mentioned here.
J1 and J6, the EXTERNAL and INTERNAL drive connectos, respectively, are in parallel, with the exception of pins 14, 21, 22, and 26.
A disk phase of SIDE 2/1 failure will usually also show up as a switch failure in the paddle port test.
The RC filter networks at N13 and M13 are also a good place to check for problems. (See the section below on useflu addresses in order to toggle a particular signal).

KEYBOARD failures are another of those problems that, while they occur frequently, are neverthelesss, failry simple fo correct. Some fo the more common failure modes are:
If the fast repeat or the super fast repeat either fail to work, work all the time, or repeat way too fast, check the 556 located at L10 and also the C16 capacitor.
Another thing to check if there is no fast repeat is diode CR5, located M7.
If the data from the keyboard is wrong, check the keyboard encoder chip at H14, (check its power connections too,) or one of the 74LS257's located at H12 or J12.
If one of the above hasn't led to the problem, check the 74LS05 at H9, or the 74LS132 at H10.
Lastly, if the power light of the keyboard fails to light, check transistor Q9.
ROM failures are almost ALWAYS, (99% of the time), the ROM chip itself located at B9. On rare occassions, it could be that the IC located at F9 is NOT a 341-0055, as it should be.

THERMAL or "HEAT SENSITIVE" failures: (These should be vertified as heat sensitive as described in section 4.4 above).
After vertifying that the unit is actually heat sensitive, you will have to locate the area of the board where the problem is. Do this by looping on the portion of the diagnostic that failed and moving the heat gun over the affected areas. If the unit does not fail within a few minutes, move the heat gun to a different area fo the board and continue the process.

When the test begins to fail, you have found the correct AREA of the board.
You may now want to use, a monitor command of some type with the X (or repeat) command, for your troubleshooting.
The most frequently heat sensitive devices are the ROM located at B9, the 6502-B located at B7, and the 7643 PROMS (with the 342-00xx numbers), scattered throughout the board.

TROUBLESHOOTING INFORMATION`

SYSTEM DEATH ERRORS and their meaning:

error code	meaning
$01	bad break (BRK) from SOS
$02	interrupt not found (but received at CPU)
$03	bad zero page allocation
$04	unable to lock NMI
$05	event queue overflow
$06	stack overflow
$07	data manager detected invalid request code

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$08	dmgr - too many device handlers (drivers)
$09	memory too small (<64K)
$0A	volume control block not usable
$0B	file control block crashed
$0C	allocation blocks invalid
$0D	directory is not correct
$0E	pathname buffer overflow (too long)
$0F	invalid buffer number
$10	invalid buffer size (=0 or >16K)

^ul

MONITOR AND ESCAPE COMMANDS

MONITOR COMMANDS:

COMMAND	REMARKS
addr1 addr2	memory dump, to dump all memory locations from address $30FF you would type, 3000. 30FF and press RETURN.
addr1:byte list	store byte(s) in memory, just like Apple }{, to store data starting at address $3000, you would type, 3000.00 A2 FF 45 9C etc. To store ascii data, you would type, 3000: 'DARRELL' for high bit off, or 3000: "PAYNE" for hihg bit on.
block <addr1.addr2	read block from disk into memory from address 1 to address 2. Block must be in the range $0 to $117 (0-280). For example, 0<2000.20FF would read block 0 of the disk and store the data in memory form $2000 to $20FF. NOTE: 1 block + 512 bytes, and the SOS directory is at block 2.
block <addr1.addr2W	same as above except writes data from address 1 to address 2 onto the disk starting at block.
addr3<addr1.addr2M	move data from memory beginning at location address 1 and ending at address 2 into memory beginning at address 3.
addr3<addr1.addr2V	Vertify that the date in memory from address 1 to address 2 is the same as data in memory beginning at address 3.
byte<addr1.addr2S	search memory for data that matches byte starting at address 1 and continuing search through address 2.
addrG	call subroutine at address. This is the same as a JSR in assembly language, or a CALL in BASIC .
addrJ	jump to address and begin executing code. This is the same as a JMP in assembly language.
U	calls user routine. This actually does a JSR $3F8.
X	repeat entire command line. For example, C0E0/C0E1/X will continue to toggle disk phase 0 on and off.

Note that most of the Monitor commands are the same as they are in the Apple }{, except some have been added and others have been improved.

^UW, 1,2

ESCAPE COMMANDS: These are achieved by pressing the escape key followed by the desired command:

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COMMAND	REMARKS
Cntl-K or up arrow	moves cursor up
cntl-J or dn arrow	moves cursor down
cntl-H or left arrow	moves cursor left
cntl-U or rt arrow	moves cursor right
L	clear to end of Line
P	clear ro end of Page
S	clear screen
4	set 40-column display
8	sey 80-column display

using the monitor to cause a particular signal or group of signals to toggle back and forth between high and low levels, can be a valuable troubleshooting tool. Listed below are some commands you can use from the monitor to do this. They are listed as they are found on the Apple /// schematic, by signal name, (all signals on sheet 2 of the schematic are grouped together, page 3 signals likewise, etc.) The signal name is given first, and the next line gives the Monitor commands you must enter to toggle that signal. {C}, means hold down the control key while pressing the next key, and {R} means press the return key. (NOTE: After you have typed a sequence of monitor instructions and used the oscilloscope to look at the signals produced, if you need to look at some different signal, ALWAYS reset the system, and use the CONTROL, APPLE, RESET sequence to re-initialize the system since it could possibly be in an unknown state, caused by either the problem you are trying to isolate, or the last instruction that you typed in).
Page 1 signals are listed on the page where they originate.
Page 2 signals are normally all running. Address lines and bank switch signals are listed on the page where they originate.
Page 3 signals
Address lines:
FFDO: O/FFDF :1F/FFEF" O{R}
O.FFFF/X{R}
Data lines and R/W:
3000:A5 5A/3000.3001/X{R}
Page 4 signals:
GB outputs, (74LS139)
FFCO/FFDO/FFEO/FFFO/X{R}
J6 outputs, (74LS138)
C000/C100/C200/C300/C400/C500/C600/C700/X{R}
K4 OUTPUTS, (74LS138)
C080/C090/C0A0/C0B0/C0C0/C0D0/C0E0/C0F0/X{R}
K7 outputs, (74LS138)
C000/C010/C020/C030/C040/C050/C060/C070/X{R}
H6 outputs, (9334)
C050.C05F/X{R}
6522, Port A, (Environment register)
A000.A2 5A A0 A5 8E DF FF 8C DF FF 4C 04 A0{R}
A000G{R}
6522, PORT B, (Zero page register)
A000: A2 5A A0 A5 8E D0 FF 8C D0 FF 4C 04 A0{R}
A000G{R}
Page 5 signals should always be toggling if the screen is enabled, and something is being sent to the screen, (whether or not it actually gets there).

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Page 6 signals
L13 outputs, (9334)
C0E0.C0EF/X{R}
L12 OUTPUTS, (9334)
C0D0.C0DF/X{R}
Page 7 signals
BCKSW1-BCKSW4
A000:A2 5A A0 A5 8E EE FF 8C EE FF 4C 04 A0{R}
A000G{R}
L7 outputs (bit 7 only), 74LS251
C060. C06F/X{R}
Sound signals will toggle continuously from sound test ACIA signals
C0F0: 55/C0F0/C0F0:AA/C0F0/X{R}
Page 8 signals
Keyboard A port read
C000/C010/X{R}
Keyboard B port read
C008/C010/X{R}
Page 9 signals should all be running. These are all of the main timing signals for the Apple ///.
Useful addresses to know:
If you wish to know the status of the CPU at the time of a system failure, ($010-$10), you can use CONTROL-APPLE-RESET, to enter the monitor and then examine memory beginning at $19F0, for the information. NOTE, this applies ONLY when the failure occurred while running under control of SOS.
$19F0-19F1.....PROGRAM COUNTER
$19F2.....STACK POINTER
$19F3.....ENVIRONMENT REGISTER
$19F4.....ZERO PAGE REGISTER
$19F5.....BANK REGISTER
$19F6.....PROCESSOR STATE REGISTER
$19F7.....ACCUMULATOR (A REGISTER)
$19F8.....INDEX X (X REGISTER) *****
$19F9.....INDEX Y (Y REGISTER)

***** NOTE: If the failure was a $02, (interrrupt not found the index register X should contain one of the following codes:

$00..... IONMI was the interrupt
$01..... ACIA was the interrupt
$02..... CA2 from 6522.E was the interrupt
$03..... CA1 from 6522.E was the interrupt
$04..... shift register from 6522.E was the interrupt
$05..... CB2 from 6522 .E was the interrupt
$06..... CB1 from 6522 .E was the interrupt
$07..... Timer 2 from 6522> e was the interupt
$08..... Timer 1 from 6522. E was the interrupt
$09..... CA2, 6522.D
$0A..... CA1, 6522.D (ANY SLOT but no slot found)
$0B..... Shift register, 6522.D
$0C..... CB2, 6522.D
$0D..... CB1, 6522.D
$0E..... Timer 2, 6522.D
$0F..... Timer 1, 6522.D

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$10..... >>>INTERRUPT NOT FOUND <<<
$11..... SLOT 1 was the interrupt
$12..... Slot 2 was the interrupt
$13..... Slot 3 was the interrupt
$14..... Slot 4 was the interrupt
Keyboard:
C000 - "KA" Port
Bit   7     6     5     4     3     2     1     0
     drdy   d6    d5    d4    d3    d2    d1    d0
     C008 - "KB" port
     7      6     5     4     3     2     1     0
     d7     kybd  A2    A1    alk   ctrl  sft   anyky
     A2 is solid apple switch
     A1 is open apple switch
     alk ia alpha-lock
     ctrl is control
     sft is shift key (either one)
     C010 - keyboard reset
     Speaker
     C030 - toggle speaker (same as Apple }{
     C040 - Hardware bell (one beep)
     FFE0 - Bit 0 - 5 Apple /// sound (D-A)
     Screen Control
     C050 - C057 (see sheet 4 of schematic)
     C050,C051 - TEXT mode
     C052,C053 - MIX mode
     C054,C055 - PAGE 2 mode
     C056,C057 - HIRES mode
     Joysticks, switches, and printer port
     C058 - C05F (se sheet 4 of schematic)
     C058,C059 - PDL0, Address 0 of A/D
     (also disable/enable output handshake)
     C05E, C05F - AXC0, Address 1 of A/D
     (output handshake line false/true)
     C05A,C05B - PDL2, Address 2 of A/D
     C05C,C05D - A/D ramp start
     (NOTE: To read a particular joystick pot set correct address
     as follows:      A3   A2   A1  <---Address lines
     joystick #1 (X0)  0    0    1
        "        (Y0)  0    1    0
     joystick #2 (X1)  0    1    1
        "        (Y1)  1    0    0

     Then use C05D to enable the RAMP of the A/D.
     Bit 7 of C060 is switch 0
              C061 is switch 1
              C062 is switch 2
              C063 is switch 3
              C066 is the joystick timeout (selected above)
     CODC, CODD  is ENSEL (direction of CB1 in 6522. D, SC0)
     CODE, CODF  is ENSIO (serial data R/W in 6522. D, SER)
     C064, Bit 7 is IRQ3 and
     C065, Bit 7 is IRQ4
     C09X is Device select for Slot 1
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COAX is Device select for Slot 2
COBX is Device select for Slot 3
COCX is Device select for Slot 4
C1XX is IO select for Slot 1
C2XX is IO select for Slot 2
C3XX is IO select for Slot 3
C4XX is IO select for Slot 4
CODA disables Character Generator RAM write, and
CODB enables Character Generator write.
COD8 disables hire scroll, and
COD9 enables hires scroll.  If enables, then
COE0, COE1 is set/clear address VA1
COE2, COE3 is set/clear address VB1
COE4, COE5 is set/clear address VC1
VC1   VB1   VA1  results in...
 0     0     0   no scroll
 0     0     1   1 horizontal line wrap
 0     1     0   2 horizontal line wrap
 0     1     1   3 horizontal line wrap
 1     0     0   4 horizontal line wrap
 1     0     1   5 horizontal line wrap
 1     1     0   6 horizontal line wrap
 1     1     1   7 horizontal line wrap
Disk drive Addresses
COD0, COD1 clear/set external drive address A0
COD2, COD3 clear/set external drive address A1
COD4, COD5 enable, external drive power
COD6, COD7 Side 1/Side 2 signal.  If COD4 (enable), then
A0   A1    Results in...
0    0     no external drive
0    1     external drive #1
1    0     external dirve #2
1    1     external drive #3
COE0, COE1 disk phase 0 set/clear
COE2, COE3 disk phase 1 set/clear
COE4, COE5 disk phase 3 set/clear
COE6, COE7 disk phase 3 set/clear
COE8, COE9  drive motor disable/enable (begins time out)
COEA, COEB  select internal/external drive
RS-232 Port, ACIA, (6551)
COF0 is received or transmitted data
COF1 Writing any data causes a programmed reset, while Reading the
following:
Bit  7      6      5      4      3      2      1      0
     IRQ    NOT    NOT    TDRO   RDRf1  OVERR  FRMERR PARERR
            DSR    DCD
COF2 is the command register:
Bit 7-5 are parity check controls
Bit 4 is ECHO control
Bit 3-2 are transmit controls
Bit 1 is INT
Bit 0 is DTR
COF3 is the control register:
Bit 7 is STOPB
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Bit 6-5 are word length
Bit 4 is NOT XCLOCK
Bit 3-0 are the BAUD rate
VIA 6522 system control registers
FFD0 - Zero Page Register (Z register)
FFDF - Environment register (E register)
Bit  7      6      5      4      3      2      1      0
  1  MHz    IOEN   SCRN   RSTEN  WPROT  PRSTK  ROM 1  ROMEN
FFD2 - data direction register B
FFD3 - Data direction register A
FFD4 - FFD7 Timer 1
FFD8 - FFD9 Timer 2 (used by printer port)
FFDA - Shift register (used by printer port)
CA1 (in) Anyslot IRQ (will not clear)
CA2 (in) printer port input handshake
CB1 (out) Printer port clock
CB2 (out) Printer port serial data
CB2 (out) joystick address 0 set/clear
FFE0 - interrupt flags in / sound out
Bit 7 - IONMI (in)
Bit 6 - IOCT (in)
Bit 5-0 interrupt flags in / bank register (in/out)
Bit 7 - NOT GIRQ
Bit 6 - Not A }{SW
Bit 5 - Not IRQ2
Bit 4 - Not IRQ1
Bits 3-0 - Bank register (B register)
FFE2  - Data direction register B
FFE3  - Data direction register A
FFE4  - FFE7 Timer 1
FFE8  - FFE9 Timer 2 (input to IOCT flag)
FFEA  - Shift register (used for VBL)
CA1 (in) clock/calendar IRQ
CA2 (in) keyboard IRQ
CB1, CB2 (out) vertical blanking
List of interrupt flag location:
C000 - Bit 7 = Keyboard
C064 - Bit 7 = Slot 3
C065 - Bit 7 = Slot 4
C070 -       = real time clock (function in Z reg)
FFDD - Bit 0 = CA2, printer port input handshake
       Bit 1 = CA1, anyslot IRQ
       Bit 2 = shift register
       Bit 3 = CB2
       Bit 4 = CB1
       Bit 5 = Timer 2
       Bit 6 = Timer 1
       Bit 7 = IRQ, any of the above 7 IRQ's
FFE0 - Bit 6 = IOCT
       Bit 7 = global IRQ, any IRQ in the system
       Bit 5 = Slot 2
       Bit 4 = Slot 1
FFED - Bit 0 = CA2, keyboard
       Bit 1 = CA1
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Bit 2 = Shift register
Bit 3 = CB2, VBL x 8
Bit 4 = CB1, VBL x 1
Bit 5 = timer 2, IOCT (slot)
Bit 6 = Timer 1
Bit 7 = IRQ< any of the above 7 IRQ's

Vertify the problem found. Whenever it is practical always try to replace the problem that you removed to see if the same symptom previously encountered returns. If you have indeed, found the correct problem, the same symptom will return. Otherwise, the probelm probably still exists and further troublshooting is called for.

Vertify the fix. Once you are confident that you have repaired a problem, RETEST the ENTIRE system using ALL of the methods, described above in section 4.0. If no further problems are encountered log and label the board as repaired, making sure that ALL documentation, including SYMPTON, SOLUTION, and METHOD pf fault isolation, (especially if it was a tricky one), are included. If you DO find another problem, then RESTART the diagnostic procedure and attempt to isolate and repair the NEW problem that you ahve encountered. Repeat the entire process as necessary, until ALL problems have been identified and corrected.

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APPLE /// COMMON FAILURES (FOR SHOTGUNNING)

SYMPTOM	PROBABLE CAUSE
SELF TEST (F6E6G)	
Self-Test but characters wrong	74S257 (U66 [C12], U69 [C13]) 74LS374 (U4, [M13])
Self-Test with ACIA error message	6551 (U98 [B10])
No-Reset	B8, D13
A/// FINAL TEST: PART A	
No-Boot: CAS128 CASE256 C13(12V) C13(5V) Prom 42 63	[M14], D3, G13, G11
Video:	
Wrong colors	C5 100 pf
Random Patterns	B8, F10, G11
Sound:	
No sound or weak sound	LM380 (U103 [14])
Sound does't sweep	6522 (U97 [G10])
Serial Port:	
Fails	6551 (U98 [B10])
Paddle Port:	
Switch Fails	74LS251 (U101 [J11])
Paddle Fails	9708 (U105 [L5])
ROM:	
Fails:	341-0031 (U64 [D10])
A/// FINAL TEST: PART B	
Printer Port	6522 (U73 [H10]) 74LS125 (U160 [M4]), 74LS126 (U161 [I7])

This by no means exhaust the possible failures. Try to use your technical ability to find out what's wrong.

Bob Edgington
10-24-80

RAM FAILURE MAP

8	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1
6	B9	B8	B7	B6	B5	B4	B3	B2
5	B17	B16	B15	B14	B13	B12	B11	B1
4	C17	C16	C15	C14	C13	C12	C11	C1
3	D9	D8	D7	D6	D5	D4	D3	D2
2	D17	D16	D15	D14	D13	D12	D11	D10
1	C9	C8	C7	C6	C5	C4	C3	C2
	1	2	3	4	5	6	7	8

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THE RAM FAILURE MAP INDICATES THE PHYSICAL LOCATION (COORDINATES OF THE RAM FAILURE. FOR EXAMPLE, IF WE OBSERVE INVERSED 1'S FOR THE LOWER ROW THIS WOULD CORRESPOND TO A RAM(S) OR RAM ADDRESS FAILURE AT LOCATIONS C9-C10 ON THE MEMORY BOARD.

8	B9	B8	B7	B6	B5	B4	B3	B2
7	B17	B16	B15	B14	B13	B12	B11	B10
6	B9	B8	B7	B6	B5	B4	B3	B2
5	B17	B16	B15	B14	B13	B12	B11	B10
4	C17	C16	C15	C14	C13	C12	C11	C10
3	D9	D8	D7	D6	D5	D4	D3	D2
2	D17	D16	D15	D14	D13	D12	D11	D10
1	C9	C8	C7	C6	C5	C4	C3	C2

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RAM FAILURES ARE INDICATED BY INVERSE 1's

RAS OR CAS FAILURES ARE DISPLAYED AS A FAILED ROW (INVERSE ONE'S

INDIVIDUAL RAM FAILURE (INVERSE 1's) CAN BE DUE TO RAM OR RAM ADDRESSING

A111 ROM/PROM INFO

6/30/-7

LOC	A111 P/N	DESCRIPTION	SECTION	GENERIC PART	CHECK SUM
G9	341-0030	ROM, SYNCHROM	TIMING	①	2E85
	*342-0145A	ROM, SYNCHROM (INTERLACE UPGRADE)		①-2	
B9	341-0031	ROM, BOOT/MONITOR B&T		①-2	29EA
G5	341-0032	ROM, VIDEO CONTROL	VIDEO	①-2	5230
C13	341-0042	PROM, CAS128 (-12V)	ADDR LOGIC	②	
	*342-0063	PROM, CAS256 (+5V)		②-7	
C11	341-0044	PROM, RAS65 (-12V)	ADDR LOGIC-7	②	
	*342-0061	PROM, RAS65 (+5V)		②-7	
F5	341-0045	PROM, 1024X4	I/O LOGIC	②	
K11	342-0028	PROM, STATE MACHINE PGA	DISK I/O		
C10	342-0043	PROM, 1024X4	RAM ADDR	②	
F7	342-0046	PROM, 1024X4	TIMING LOGIC	②-4	
F9	342-0055	PROM, 1024X4	RAM ADDR	②	
C12	342-0056	PROM, CASB65 ADDRESSING	RAM ADDR	②-4	

① -1D2716 (NEC
-AM2732DC CAMD

② 7643
- 1. TBP24S41 (TI)
- 2. HM7643A (HARRIS)
- 3. DM74S573 (NAT)
- 4. 82S137AN
- 5. AM27S33DC (AMD)
- 6. TBP24S41 (T.I)
- 7. 82S137AN