VIDEO RECAP

CPU BOARD

Part 1

Logic Probe Troubleshooting

SERVICING SERIES

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LOGIC PROBE TROUBLESHOOTING

Welcome to Williams Electronics video-based servicing series. This recap sheet contains the most important points covered in the accompanying video tape. This recap covers troubleshooting the CPU board for the Defender game, using a multimeter and a 3-state logic probe.

Use the recap sheet to assist you in recalling information as you need it while performing your work. The recap sheet includes a flow chart for each troubleshooting step shown in the tape. The flow chart tells you where to test, and what to look for.

Most CPU board faults can be found using the logic probe and the flow chart. If you should need to use an oscilloscope, refer to Part II of this series, which covers oscilloscope troubleshooting of the Defender CPU board.

CPU BOARD CONTAINS THE "BRAINS"

The CPU board in the Defender game contains the microprocessor "brains" of the game. The microprocessor and other circuits on the CPU board control the system according to the instructions contained in the ROM board memory.

The microprocessor and its buffers are located in the upper left-hand portion of the CPU board. The microprocessor, or MPU, reads from and writes to other parts of the Defender electronics to generate screen information which is stored in the video RAM banks.

The video RAM banks are located in the upper right-hand portion of the CPU board. The video RAM banks store the information needed for a line-by-line generation of the Defender screen presentation.

CPU BOARD CONTAINS A RESET CIRCUIT

The CPU board also contains a reset circuit to control synchronization during power up and power fluctuations, as well as E & Q and clock circuits to provide system timing signals.

The addresses used to scan the Video RAM banks are provided by the Video Address Generator.

The addresses provided by the video address generator, together with decoded vertical and horizontal selection and screen control information, are multiplexed on a 4-to-1 basis by the video RAM address multiplexer, and used to scan the video RAM banks.

Three data busses are read out of the Video RAM Banks, and into the Video Shift Registers. These convert the parallel information to serial information, for clocking the Color RAM Address Multiplexer.

The Color RAM Address Multiplexer multiplexes the shift register serial output and the input from the MPU address bus, and places the information on the Color RAM inputs.

The Color RAM, under the control of the MPU, combines the information provided by the Video RAM with MPU color selections, and sends the resulting data into the red, green and blue monitor guns.

In addition to providing the addresses used to scan the Video RAM Banks, the Video Address Generator drives the Monitor Sync Generator, the Horizontal Blanking Circuit, the Count 240 Gate and the Vertical Count Buffer.

TROUBLESHOOTING THE CPU BOARD

Let's turn now to actual troubleshooting of the CPU Board, using the flow chart, a multimeter, a logic probe, and the theory and schematic manuals.

To begin with, the video tape assumed that you had isolated the trouble to the CPU Board, and therefore covered only the troubleshooting of the CPU Board itself. If you have any doubts about the ROM Board, the Interface Board or the Power Supply, it is assumed that you will repair or change these boards prior to CPU troubleshooting.

Once you are sure that the problem is in the CPU board, check all of the connectors to the board and be sure that all socketed chips are firmly in place.

CHECK POWER SUPPLY VOLTAGES

Next, power up Defender, and check the power supply voltages on the power busses. Logic circuits will often operate erratically when supply voltages are incorrect.

When you have checked out all of the supply voltages, begin the troubleshooting by locating and testing for logic pulses on the pins of the first component in the flow chart, which is pin 37 of component 2I, the microprocessor.

This pin is the Reset circuit input. Each time you push the Reset switch, you should get a one second low pulse.

If, instead of a one second low pulse, you find that the Reset input is stuck either high or low, check the Reset circuit inputs and outputs.

If the MPU reset input at pin 37 pulses repeatedly, you should suspect that the Watchdog circuit is at fault.

Confirm the problem (check all components of the circuit for the one at fault), then replace the faulty component and recheck the circuit.

CHECK CLOCK GENERATOR AND E AND Q GENERATOR CIRCUITS

Once you are satisfied that the Rest input is correct, the next step is to check the Clock Generator and E and Q Generator circuits in the same manner.

If you have not found the problem by the time you have checked the Clock and E and Q circuits, remove and replace first the MPU, and then the Decoder ROMS, with known good components before proceeding. After you have replaced the ROMS and the MPU, check the MPU address and data buffers as described in the flow chart.

As with most of the other checks in the flow chart, you should observe pulsing at the pins listed. If a pin shows no pulsing, or is stuck low or high, confirm the problem, then repair and retest the circuit.

CHECK MONITOR SYNC GENERATOR CIRCUIT

Having confirmed that the MPU and its data and address buffers are operating correctly, and that the Clock, E and Q, Reset and Watchdog circuits and Decoder ROMS are OK, the next step is to check the Monitor Sync Generator circuit to be sure that the monitor Vertical and Horizontal sync pulses are being generated.

Monitor vertical sync pulses appear at pin 8 of chip 3A, and horizontal pulses at pin 11. The pin 6 composite signal is not used on this game. If pulses are present on both pins (8 & 11), continue with the next step of the flow chart, but if either signal is missing, check the Monitor Sync Circuit. If the outputs of the Monitor Sync Generator are correct, the next check point is the Video Address Generator.

As shown in the flow chart, the Video Address Generator is checked at the outputs of chips 5E, 5F, 5H, and 5J, and pin 2 of 5B. Any problems in pulsing should be tracked down and the circuit repaired and re-tested.

After you have completed testing of the Defender CPU through this point without finding the problem, the fault **must** be in the **video** circuits. The first check point in the video circuits is the Video RAM Control.

CHECK VIDEO RAM CONTROL

As shown on the flow chart, the Video RAM Control is checked for pulsing at chips 6P, 5P, and 4R. Lack of pulsing, or a continuous high or low level, indicates a problem in the Video RAM Control Circuit.

Once the Video RAM Control Circuit is known to be good, check the Video RAM Timing Circuit. You should see pulsing at the pins listed in the flow chart on chips 4S, 5S, 6P and 4J. Problems should be checked out and repaired. You should then retest ths RAM Control before going mn to the next circuit, which is the Video RAM Address Multiplexer.

Recall that the Video RAM Address Multiplexer receives input from the Video Address Generator, as well as decoded vertical and horizontal selection information and screen control signals. The Video RAM Address Multiplexer multiplexes this information on a 4-to-1 basis. The result is used to scan the Video RAM Banks.

During testing, you should see a Multiplexer output on pins 7 and 9 of chips 4F, 3G, 3I and 4H. Lack of pulsing, or pins that are stuck high or low indicate problems which should be solved before going on.

CHECK VIDEO RAM BUSSES

If the Video RAM Multiplexer tests good, you should next check for output on the busses of the Video RAM itself. The VIDEO Ram stores the pixel information used to generate the line-by-line screen presentation. Check for pulsing at each of the three Video

RAM data busses. The best places to check are the output pins of chips 1M, 3M and 4M.

Lack of pulses at the output of the Video RAM can be due to a variety of problems within the Video RAM Circuit. If you have a problem with this circuit, change all of the RAM chips.

After you change the Video Ram chips, recheck the circuit for output. If the chip change has solved the problem, remove one of the new RAM chips and try each of the old chips in turn, until the circuit hangs up. Once you have located the defective RAM chip, cut off the leads and discard it to avoid mixing it with reuseable parts. Return the remaining chips to your parts supply.

CHECK OUTPUT OF VIDEO SHIFT REGISTERS

Assuming you still haven't found the problem, but know that you have a good output from the Video RAM, the next check point is the output of the Video Shift Registers.

The Video Shift Registers receive the 24 bit parallel information on the three Video RAM Data Busses and convert it into a 4-bit serial output at pins 4, 7, 9 and 12 of the Video Shift Register Multiplexer 2M. Two identical sets of Video Shift Registers are contained in the Shift Register circuit.

The first set of Shift Registers is numbered 10, 20, 30 and 40, and is used for upright games and Player 1 in table games. The second set of registers is numbered 1P, 2P, 3P and 4P, and is selected for Player 2 in table games. The screen control input of the 2M Multiplexer chip selects the set of Registers to be read out.

The screen control input pin is one of the few pins in the CPU troubleshooting procedure which should either be high or low and **not** pulsing. When the screen control input is low, Registers 10, 20, 30 and 40 are selected. When the screen control goes high, Registers 1P, 2P, 3P and 4P are selected.

Test for a pulsing output on the Video Shift Register Multiplexer pins, as indicated in the flow chart. If you fail to get output, you can use the double set of registers to help troubleshoot the circuit. Here is how that is done.

First, locate and jumper W1 on the CPU Board. Notice that one end is connected to pin 9 of chip 5B, and the other end is connected to a pad higher in the board. Unsolder and lift the end of the jumper which is connected to the pad higher on the board, and clip a test lead to the now free end of the jumper.

Bring the other end of the test lead back to the ground bus running around the outside of the board. Touch the jumper to the ground bus at a mounting screw point or other bare spot. When you ground this connection with the game running, the screen should flip (on both the upright and cocktail versions of the game). Ungrounding this jumper will re-flip the screen.

Grounding the jumper pulls the screen control low, and selects registers 10, 20, 30 and 40. Removing the ground allows the screen control to go high, selecting registers 1P, 2P, 3P and 4P. In a working game, this causes the screen to invert, then return.

Place your logic probe at pin 1 of chip 2M as you ground and unground the screen control. If you do not see a change from high to low level, then the 5B chip is defective. If the level changes but there is no change in the output of the 2M Multiplexer chip, the Multiplexer is probably defective. If you only get output with the screen control in high or low, but not both states, then the set of registers selected when the output pulsing stops is probably defective. After you have located and repaired the problem, retest the circuit and go on to the next step, which is the checking of the Color RAM Driver Circuit. You should see a pulsing output at load resistors R17, R19, and R21.

CHECK OUTPUT OF COLOR RAM CHIPS

If you don't see a pulsing output, check the output of the Color RAM chips 1C and 2C, then the output of the Color RAM Address Multiplexer 2E.

You should also check the Write Color RAM Not signal at the pin 12 output of chip 6J, and the S Not input to pin 1 of Multiplexer chip 2E. Finally, check for a pulsing blanking signal at resistor R23, which is tied to the base of transistor Q4.

If you find that the blanking pulse is not present at the base of Q4, or if there is a signal but you still have video problems, you should first check the output of the blanking circuit at pin 8 of chip 4B.

If the output of the Color RAM Driver Circuit is OK but there is still a video problem, check the Blanking

Circuit, the Page 0 Decoder Circuit, the Vertical Count Buffer Gate, and the Count 240 Circuit. Each of these circuits can affect the video output.

CHECK VERTICAL COUNT BUFFER CIRCUIT

Notice that the check point for the Vertical Count Buffer Circuit is at the input of OR gate 5P. If you don't see pulsing at the output on pin 6 of this gate, disconnect this pin, and check again for pulsing on the disconncted pin. If you still don't see pulsing, but know that the Page 0 Decoder and Page Select Decoder inputs are OK, then the gate must be bad. If the pulsing is good at the output of the gate, but you don't see pulsing at the outputs of 3D with the pin connected, then the Vertical Count Buffer is bad.

CHECK COUNT 240 CIRCUIT

The next circuit to check is the Count 240 Circuit. This circuit produces an interrupt for the MPU, indicating that the scan is at the bottom of the screen. The circuit is checked at pin 8 of chip 4C.

CHECK CMOS RAM

At this point, you will have checked all of the main components of the CPU Board with the exception of the CMOS RAM. The CMOS RAM contains game adjustments and audit information.

The CMOS RAM also has its own, on-board battery power supply.

A variety of problems canoccur with the CMOS RAM. Some of the problems can affect game play, others will affect only the audit information display.

The video tape covered the most common of these problems, which are: low on-board battery voltage, complete battery failure, and problems with page selection.

Low battery voltage or complete battery failure causes the game to go immediately to audit totals after startup.

A similar situation can occur with CMOS RAM failure, but here the total column will contain question marks, indicating that the program has recognized the CMOS RAM failure. This type of CMOS RAM failure is usually picked up by the on-board diagnostics.

If you have a game which goes immediately to audit totals without the question marks, you should suspect some type of problem in either the battery or the diodes associated with it.

For such a problem, check the voltage at the cathode of the blocking diode D14. You should read at least 4 volts DC with Defender turned off. With the power on, there should be about 5 volts on the CMOS buss. These diodes occasionally fail, so it is a good idea to check forward and reverse voltage drops across diodes D13 and D14, which connect the CMOS RAM buss with the main DC buss.

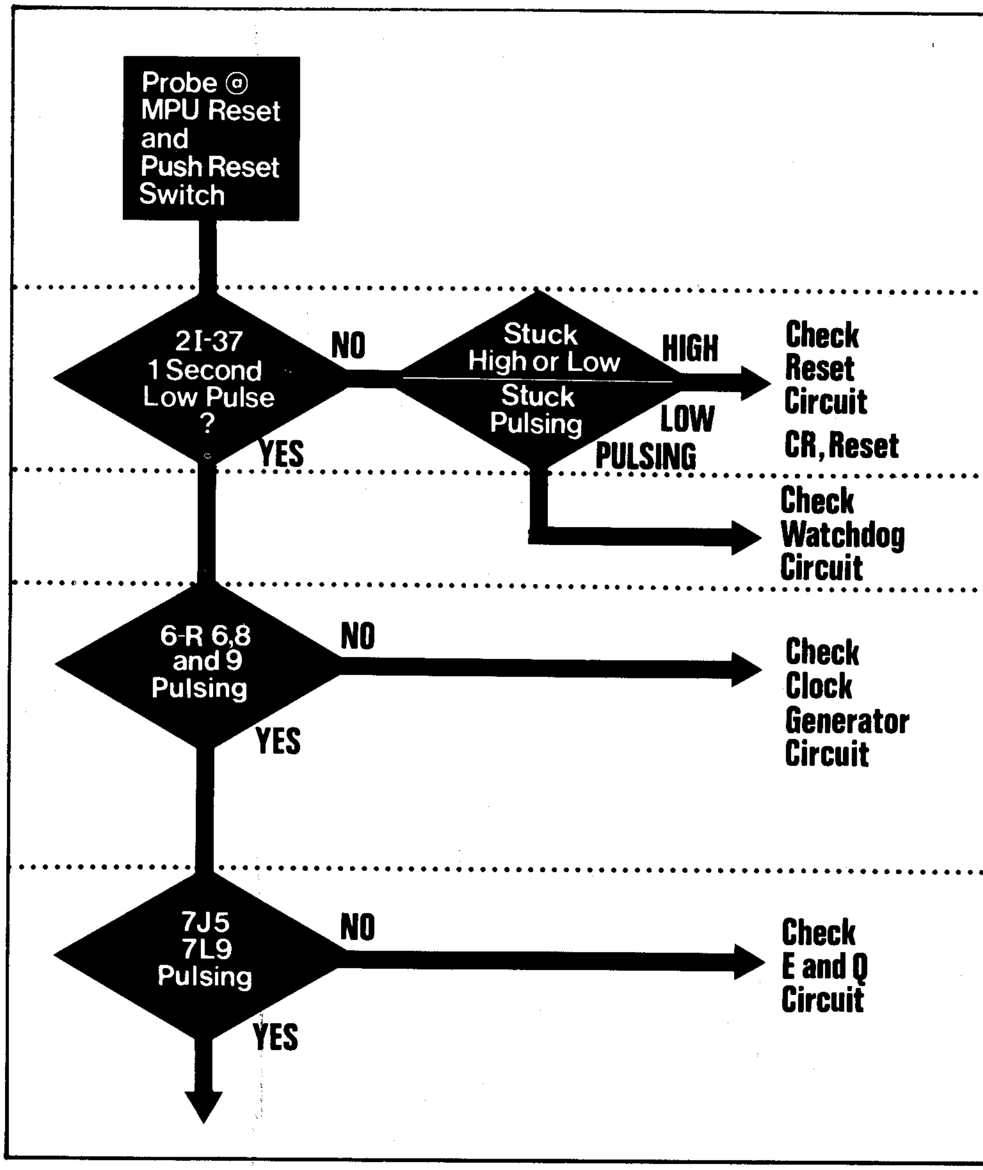
Instructions for reading the CMOS RAM are contained on Page 0 of the main program. For this reason, problems with the Page Select Decoder or Page 0 Decoder can also cause the program either to stay in the audit mode regardless of switch settings, or to revert to factory game settings. If you have a game which shows these problems, be sure to check the Page Select Decoder and Page 0 Decoder before proceeding.

Remember that CMOS RAM failures, or on-board power supply problems cause all audit information to be lost, as well as game settings. Don't forget to re-program the game settings after you have completed repair and checkout of the system.

CONCLUSION

This concludes the logic probe checkout of the CPU Video Board. If, after completing all of the tests shown on the flow chart and described in the tape, you have not found the problem, then you should recheck the CPU Video Board with the aid of an oscilloscope. This procedure is covered in another tape entitled CPU Oscilloscope Troubleshooting.

LOGIC PROBE TROUBLESHOOTING FLOWCHART

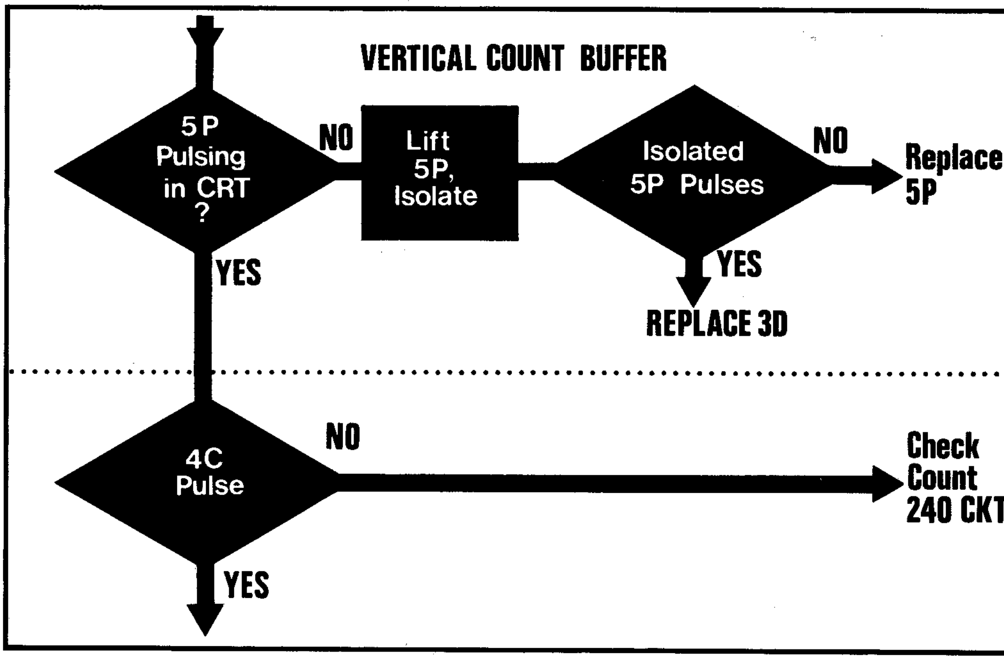


1st Test Points:

CHIP	PIN(S)
2I	37 (1 Second Low, Then High)
7J	9,13 (1 Second Low, Then High)
5M	13 (1 Sec Low, Then High)
6R	6,8 9
7J 7L	5 9

Replace MPU and then Vertical and Horizontal Decoder ROMs

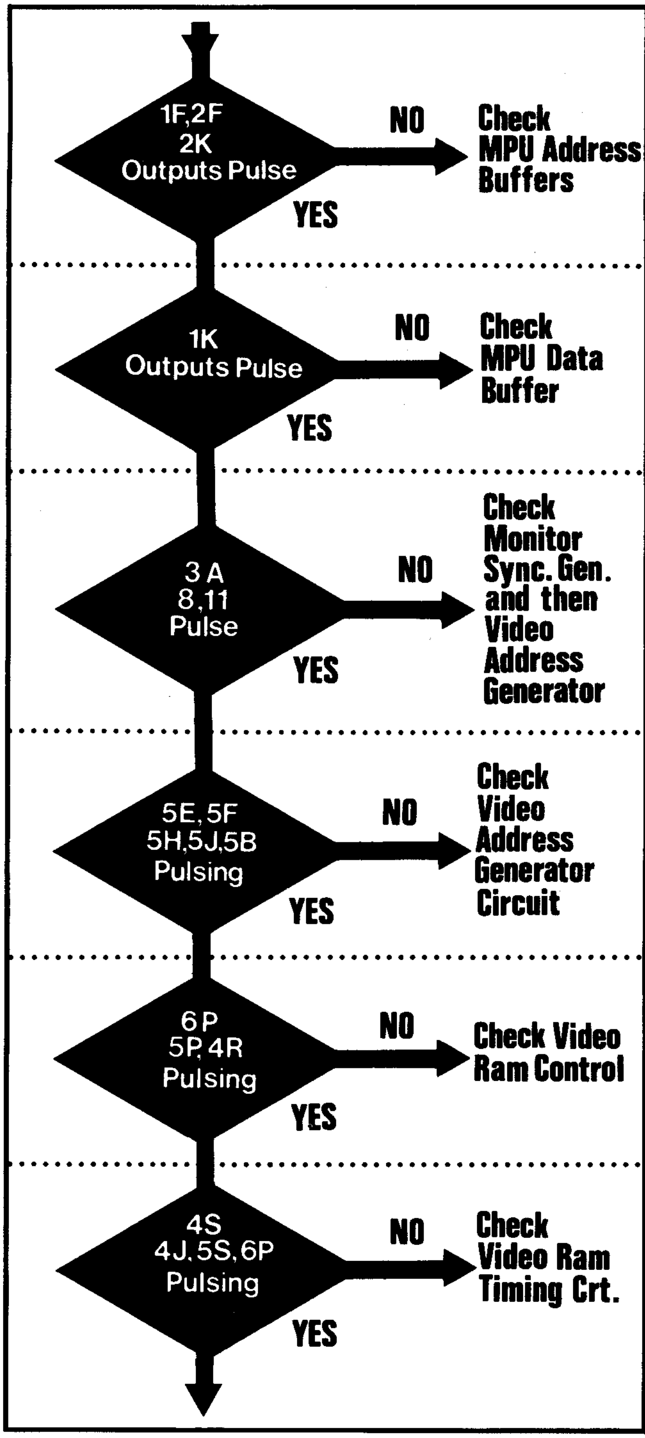
LOGIC PROBE TROUBLESHOOTING FLOWCHART



1st Test Points:

CHIP	PIN(S)
5P	6
4C	8

LOGIC PROBE TROUBLESHOOTING FLOWCHART



1st Test Points:

CHIP	PIN(S)
1 F	3,5,7,9,11,13
2 F	3,5,7,9,11,13
2K	3,5,7
1K	2,3,4,5 6,7,8,9,19
3 A	8,11 (See Next Page for Video Address Generator)
5E	2,11,12,13,14,15
5F	2,11,12,13,14,15
5J	2,11,12,15
5B	2
6P	6,12
5P	3,11
4R	6,11,8,3
4J	8
4S	8,9
5S	5,6
6P	8

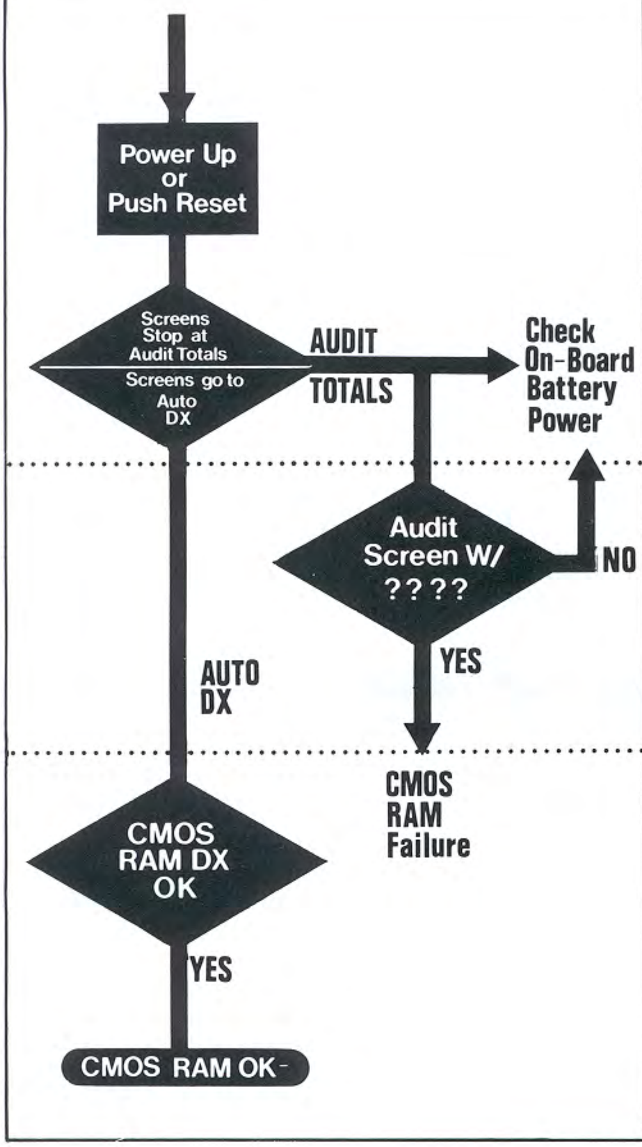
LOGIC PROBE TROUBLESHOOTING FLOWCHART

1st Test Points:

Test (YES → next step)	NO	CHIP	PIN(S)
3G,3I 4F,4H Pulsing	Check Video Ram Address MVX	3G 3I 4F 4H	7,9 7,9 7,9 7,9
1M,3M 4M Pulsing	Check Video Address Ram	1M 3M 4M	2,5,6,9,12,15,16,19 2,5,6,9,12,15,16,19 2,5,6,9,12,15,16,19
2M Pulsing	Check Video Shift Registers	2M	Change Out Video Ram Chips 4,7,9 12
Q1 Q2 Q3 Pulsing	Check Color Ram Circuit	Resistors R-17 R-19 R-21	 – – –
4K,6K Pulsing	Check Blanking Circuit	4B	8
4B Pulsing	Check Page ø Decoder Circuit	4K 6K	4,5,6,7 8

LOGIC PROBE TROUBLESHOOTING FLOWCHART

1st Test Points:



Cells B-1 B-2 B-3	~4.0 Volts D.C.
Diodes D-13 D-14	Fwd./Rev. Voltage Drop

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