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ABC Diagnostics Kit User's Manual

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Introduction

Congratulations on your purchase of the ABC DIAGNOSTIC and REPAIR KIT from **Two Bit Score, Inc.** The kit is intended to be used in conjunction with this manual to provide a comprehensive way of diagnosing common (and some not-so-common) circuit board problems with all models of the BALLY/MIDWAY brand coin-operated video games PACMAN, MS. PACMAN, and PACMAN PLUS. It can be used to diagnose problems in the RAM, video circuitry, switches, and motion objects (sprites), as well as to help you to adjust your monitor.

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What Your Kit Comes With

These items come pre-assembled:

- 1) **TWO BIT SCORE ABC ROM Board:**



- 1) **DIAGNOSTICS SOFTWARE Chip:** This ROM contains the software to run the diagnostic program. It ignores any ROMs which may be in the sockets on the main board at locations 6E through 6J.
- 1) **40 pin Ribbon Cable:** This is an exact replacement for the cable supplied with the original game board. You are going to find the original cables are extremely brittle with age and if any ONE of the forty connections it carries fails even for an instant, the game will reset. As a general rule, you will be replacing the original ribbon cable on most service calls.



- 1) **Z-80 40 pin Processor Chip:** The "brain" of the machine.



These items come separately packaged:

- **CHIP PULLER** Use this tool to remove chips from their sockets without damaging the circuit board.



- **1) 74LS161 Chip:** A common chip found in several places on the main board that can be used to resolve many problems. If your board has a cruddy looking one in a socket at location 3R, replace it with this one right away. If your board does not have a socket at location 3R, don't sweat it.

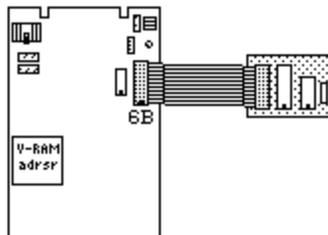


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Installation

Installation is a quick and painless affair, but differs depending on your circuit board setup:

- **PACMAN Boards:** Remove the Z- 80 chip from the socket at location 6B on the circuit board. Save it as a spare. Carefully install the ribbon cable from the DIAGNOSTICS BOARD into the socket at location 6B, making sure that the notches on the chips face the same direction as all of the chips on the main board.
- **MS. PACMAN / PACMAN PLUS Boards:** Remove the ribbon cable and attached satellite board from the socket at location 6B on the circuit board, and set it aside for later use. Carefully install the ribbon cable from the DIAGNOSTICS BOARD into the socket at location 6B, making sure that the notches on the chips face the same direction as all of the chips on the main board.



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Operation

The diagnostics program does some self-checks and initialization at startup. Listed below is the order of operations the program performs. Potential problems (and error indications) are prefaced with bullets.

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2114 RAM Test

The first test performed by the program is the 2114 RAM test. You should not proceed until your game board passes this test by jumping directly to the [TITLE SCREEN](#) at start-up.

Use the red reset button in the extreme upper right corner of the game board to force the program to reset.

At start-up, the program writes and reads each individual bit of memory in the bank of six 2114s located at 4k through 4R.

Specifically, it tests each bit in the following address ranges:

0x4000-0x43FF : Video RAM (the 2114 RAMs at locations 4K & 4N)

0x4400-0x47FF : Color RAM (the 2114 RAMs at locations 4L & 4P)

0x4C00-0x4FF1 : Scratch Pad RAM (the 2114 RAMs at locations 4M & 4R)

If there is a discrepancy (i.e., a RAM was found bad), the program will note this and display the following error screen:

```

RAM
 4 K  DVR0  FAIL
      DVR1  FAIL
      DVR2  FAIL
      DVR3  FAIL
ERROR
 4 N  DVR4  FAIL
      DVR5  FAIL
      DVR6  FAIL
      DVR7  FAIL

RAM
 4 L  DVR0  FAIL
      DVR1  FAIL
      DVR2  FAIL
      DVR3  FAIL
ERROR
 4 P  DVR4  FAIL
      DVR5  FAIL
      DVR6  FAIL
      DVR7  FAIL

RAM
 4 M  DVR0  FAIL
      DVR1  FAIL
      DVR2  FAIL
      DVR3  FAIL
ERROR
 4 R  DVR4  FAIL
      DVR5  FAIL
      DVR6  FAIL
      DVR7  FAIL

PUSH 1P START TO CONTINUE

```

Note that this unusual screen shot

is indicating that ALL the RAMs are bad

The values displayed (4K, 4L, 4M, 4N, 4P, or 4R) are the locations of the RAM chips on the circuit board the program found a problem with. The values DVR0 through DVR7 represent the data bus lines indicated on the schematic for the board. A "PASS" message indicates that there were no problems reading or writing on this data line; a "FAIL" message indicates one or more errors occurred during the RAM test. Swap known good chips with the ones listed as bad, reset the game, and see the results. There are several things to remember with this screen:

- The program **WILL NOT** get past the "BOOT" message if all three RAM types (Scratch Pad, Video, and Color) have errors!
- Bad Video RAMs will produce a garbled screen, but you should still be able to make out enough characters to read the error message.
- If you do see this RAM ERROR screen at startup, you should reset the game **at least once** and verify that it arrives at this screen again. Occasionally if the game board is jostled while it is powered up, it may report a bad RAM.
- Just because a RAM is reported bad does **NOT** mean that it actually is. There may be a cut trace or scraps of metal on the board. This can be tested by swapping a known good RAM chip for one at a location reported bad, resetting the game, and having that same location reported as having failed.

Arriving at this screen simply means that, from the *program's* perspective, the value read from a RAM location was not the same value written there.

At the bottom of the screen is a message "PUSH 1P START TO CONTINUE".

The program will wait for you to press the **1 PLAYER START BUTTON** to proceed.

- If you have passed the RAM test, but pressing the 1 PLAYER START BUTTON doesn't CONTINUE, reset the program and then proceed to the [INPUT SWITCH TEST](#).

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Stuck Switch Test

The next test tests to see if any switches are currently engaged or stuck. If no switches are detected as being engaged, the program will skip this step. Otherwise, it will result in the following screen:



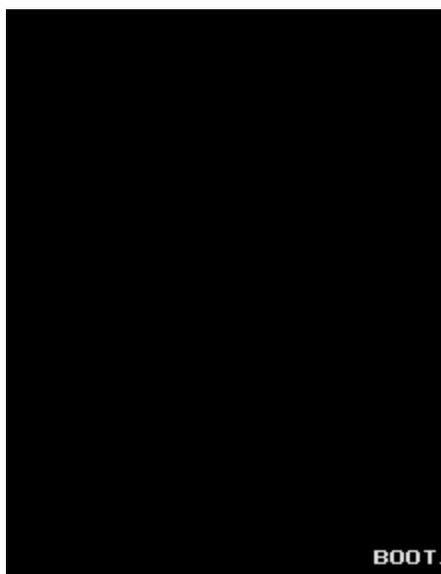
Currently engaged switches will appear in RED

A timer at the bottom of the screen will count down from 9 to 0. At 0, the program will end the Stuck Switch Test and proceed. Things to remember:

- A closed switch will be indicated in red.
- Closing ANY switch (joystick, start buttons, etc.) will reset the timer to 9.
- The lines "RM7" and "RM8" indicate the resistor networks on the game board that correspond to the particular bank of switches.

Boot Message

After the internal RAM test and Stuck Switch Test, the program will display the word "BOOT" at the bottom right of the screen, as seen below:



The "BOOT" message

- If the program flashes the word "BOOT" repeatedly (the program is actually resetting), an error may have been detected in all three types of RAM (Scratch Pad, Video, and Color), or there may be a problem with the watchdog timer.

RETURN TO THE INDEX**Title Screen**

On a functioning game board with good RAMS and no stuck switches, the previous steps should take only a fraction of a second, then you should be greeted by this screen:

*The Title Screen*

- **IMPORTANT!** If the title screen does not appear, but instead a black screen labeled "BURN-IN MODE", flip the TEST switch to enter NORMAL MODE and reset the game.

The outer edge of the screen should be surrounded by a dark blue line with a cyan border. You can use this box to adjust your monitor's VERTICAL SIZE, VERTICAL PHASE, HORIZONTAL SIZE, and HORIZONTAL PHASE settings, as the box shows the maximum size of the screen used in game play. All further screens will use this size box as well.

The box in the center of the screen (a rounded rectangle) should be surrounded by "pipe". The pipe should have a **LIGHT BLUE** interior with a **WHITE** exterior (with PACMAN PLUS color PROMs, it will have **BROWN** interior with a **YELLOW** exterior).

The text onscreen should all be **WHITE**, except the words "ABC DIAGNOSTICS", which should contain the colors: **PINK**, **CYAN**, **ORANGE**, **YELLOW**, and **RED**. The colors should cycle

(making a rainbow effect).

- If the colors don't cycle, or if not all of the colors are there, there is likely a problem with your color subsystem (4A or 7F) or color RAMs.

At the bottom of the screen is a message "HIT 1P START BUTTON TO BEGIN".

Holding down the **1 PLAYER START BUTTON** will proceed to the next screen.

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Main Menu

After the Title Screen, you should be greeted with the following screen:



The Main Menu

A large **PEACH** colored dot will appear beside the first option, the SWITCH TEST. This dot indicates the current menu selection. Use the joystick to move the dot up and down. At the bottom of the screen, the Status Bar gives a description of the current selection.

- If the dot does not move, or immediately moves to the second test and stops, it is likely one of your switches is stuck or broken.

Pressing the **1 PLAYER START BUTTON** will enter the selected test.

Note: This interface (joystick to move selection, 1 Player Start to enter selection) is used throughout the rest of the program.

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Switch Test

This test will determine which switches are closed, allowing you to test all of the inputs of your game. A **RED** item indicates that a switch is **CLOSED** or **ON**, a **WHITE** item indicates that a switch is **OPEN** or **OFF**. The SWITCH TEST screen should look similar to the one below:



Note: Your game settings may vary.

At the top of the screen (beneath the "SWITCH TEST" heading) is the status of the Test Switch (used for changing between TEST MODE and GAMEPLAY with game software, or between NORMAL MODE and BURN-IN MODE in the DIAGNOSTICS SOFTWARE). Below this appears the status of the cabinet type the board is in.

- If the cabinet type listed is incorrect (TABLE or UPRIGHT), check pin 'R' of your wiring harness. The game board 'knows' when it is a cocktail table because pin 'R' is tied to ground in the wiring harness. In an upright cabinet, there is no connection to pin 'R' of the edge connector.

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Below this is the DIP switch settings from location 9D on the circuit board. There is a number indicating the setting of each switch (a 1 indicates the switch is **ON**, a 0 indicates the switch is **OFF**), except switch 8. There is no way to detect switch 8's setting, since when **ON** the game is frozen. Ensure that switch 8 is **OFF**.

- If a switch doesn't toggle properly, it is likely that there is either a cut trace on the board, or the DIP switch package itself is faulty.

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Below the DIP switches are the player inputs. Closing any of these switches will turn that particular switch **RED**.

There are two joystick "diamonds", indicating the positions of the joysticks (a second joystick exists only on cocktail tables).

Beneath the joystick diamonds are the two coin switch indicators (COIN 2 is not normally wired), followed by the status of the SERVICE BUTTON. The SERVICE BUTTON is the little **RED** button located inside the coin door used to add a credit on the machine without incrementing the coin counter.

Below the coin and service indicators are the status indicators for the START buttons ("1P START" & "2P START").

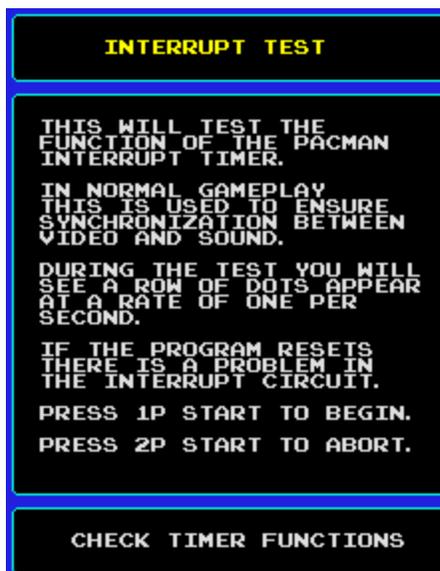
To exit the Switch Test and return to the Main Menu, hold down **ONLY** the 1P START BUTTON for 3 seconds.

- If another switch is stuck, the only way to exit this screen is to reset the game.

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Interrupt Test

The next test that is performed is the Interrupt Test. During normal game operation, a PACMAN board generates one interrupt per vertical blanking period of the monitor (VBLANK); about 60 interrupts per second. The game software uses this period to synchronize sound and video. A flaw in the interrupt circuit will prevent the software from executing and cause the game to crash.



The Interrupt Test Screen.

Press the 1P START BUTTON to execute the test, or press the 2P START BUTTON to abort the test and return to the main menu.

Executing this test will produce the word "TESTING" at the bottom. A line of dots will appear, at the rate of **ONE PER SECOND**. After 10 dots have appeared, the word "PASSED" will appear, as shown below:



TESTING. PASSED!

A successful Interrupt Test.

- If the dots appear faster than one per second, a hardware speedup hack may be present on the board.
- If the program resets, there is a problem in the interrupt circuit.
- The Sound Test will not run if there is an error in the interrupt circuit!

Press the 1P START BUTTON to return to the Main Menu.

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Watchdog Test

Similar to the Interrupt Test, the Watchdog Test will test the function of the Watchdog Timer ("WDT") Circuit. The Watchdog resets the board if not "satisfied" (written to) on a regular interval during program operation. An error in the Watchdog Circuit can be the cause of random resets.

This test ensures that the board does not reset by satisfying the Watchdog at the **LONGEST** allowable interval. In other words, if the WDT doesn't cause the program to reset during this test, it won't cause a crash during game play either.



The Watchdog Test Screen.

Press the 1P START BUTTON to execute the test, or press the 2P START BUTTON to abort the test and return to the main menu.

Executing this test will produce the word "TESTING" at the bottom, as in the Interrupt Test. Likewise, a line of dots will appear. After 10 dots have appeared (about 3 seconds), the word "PASSED" will appear, as shown below:

```
TESTING. . . . . PASSED!
```

A successful Watchdog Test.

- If the program resets, there is a problem in the Watchdog circuit.

Press the 1P START BUTTON to return to the Main Menu.

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Sound Test

- **IMPORTANT:** You **MUST** insure that interrupts are functioning properly before entering the Sound Test!



The Sound Test menu

- *NOTE:* At startup, if an error was detected in the ScratchPad RAM, the program uses the Video or the Color RAM instead. In this case, there may be garbage displayed on the right side of the screen during sound test. Try resetting the board. If the problem persists, go back to the [RAM ERROR TEST](#).

The first option, "TOGGLE SOUND ENABLE" will toggle the state of Pin 5 of the 74LS259 chip at location 8K on the game board. At the bottom of the menu, the line "74LS259 AT 8K PIN 5" will indicate what the state of that pin *should* be. Since the program can only set the state of that pin (not read it), it can only report the value last written. The state is either HIGH (+5 volts) or LOW (0 volts).

Selecting the various "PLAY SOUND" lines will play the appropriate sound listed in the Status Bar.

- Sound #6 and Sound #7 are both "repeating" sounds; that is, they continue to play in a loop. This can be helpful for debugging purposes.
- The "SQUELCH" option will stop all currently-playing sounds.

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Video Tests

Selecting the Video Tests from the Main Menu will open a sub-menu, as shown below:



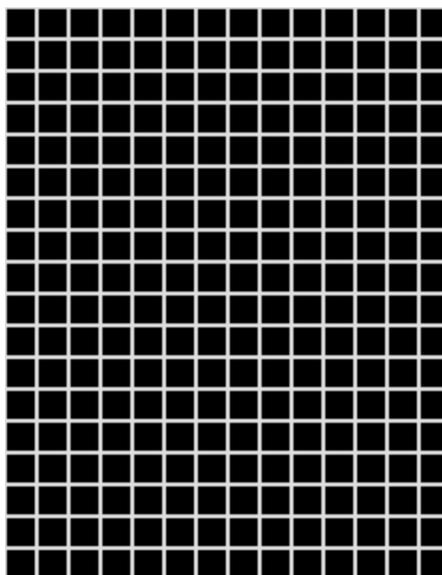
The Video Tests sub-menu

Each Video Test will be described below.

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Grid Test

This will generate a white crosshatch pattern on a black background:



The Grid Test

- Use this test to check monitor linearity. The grid should have straight, crisp lines, with square

corners.

- A broken or distorted grid can be significant of a problem in the Video RAM addressing.

Press the 1P START BUTTON to return to the Video Tests Menu.

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Color Bar Test

This test will draw a series of alternating color bars (similar to a television color-balance screen) on a black background. This test may be used to adjust monitor color settings (contrast and brightness, as well as the individual red, green and blue guns).



The Color Bar Test with PACMAN/MS. PACMAN Color PROMs



The Color Bar Test with PACPLUS Color PROMs

Note that the GREEN bar appears PURPLE.

- Note that the bars are **NOT SOLID**, but are alternating lines of color and black.
- On a board with PACMAN PLUS color PROMs at locations 4A & 7F, the "GREEN" bar will appear purple.
- This can also be used to isolate problems in the maze color generation circuits.

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Color Test

The Color Test can be used to ensure that the 4A & 7F color PROMs are functioning properly. The test appears as follows:



The Color Test with PACMAN/MS. PACMAN color PROMS



The Color Bar Test with PACPLUS Color PROMS

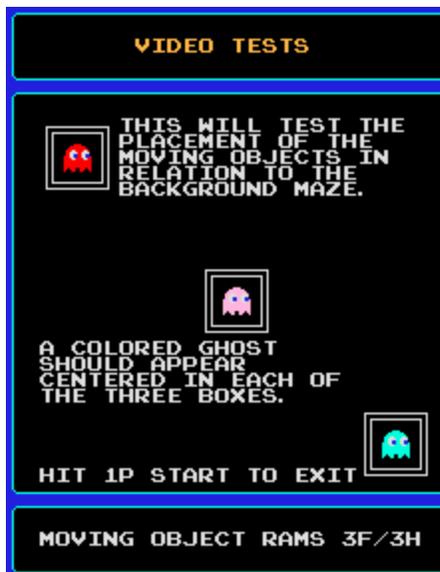
There should be 3 rows of 7 encircled power pellets. Every pellet should be visible (i.e., not black), and the surrounding "pipe" should be visible, as well.

- On a board with PACMAN or MS. PACMAN PROMS, the 3 Power Pellets in the middle of the screen will be orange.
- A PACMAN PLUS board will have white pellets.

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Sprite Location Test

This test will allow you to see whether the on- screen locations of the Motion Objects ("Sprites") are correct. Sprite locations are held in the 7489 RAMS at locations 3F & 3H on the game board. The test should appear as follows:



The Sprite Location Test

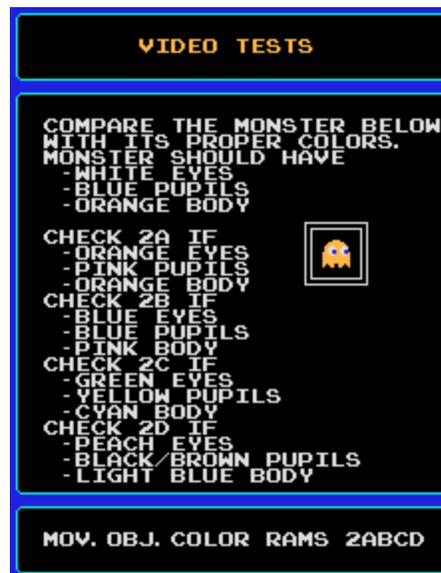
- If the ghosts do not appear centered in their respective boxes, or do not appear at all, there is likely a problem in the chips at 3F or 3H.

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Sprite Color Test

This will test the state of the 4 Motion Object Color RAMs (which can only be written to, not read from) at locations 2A, 2B, 2C, and 2D on the game board.

The screen should appear as follows:



The Sprite Color Test

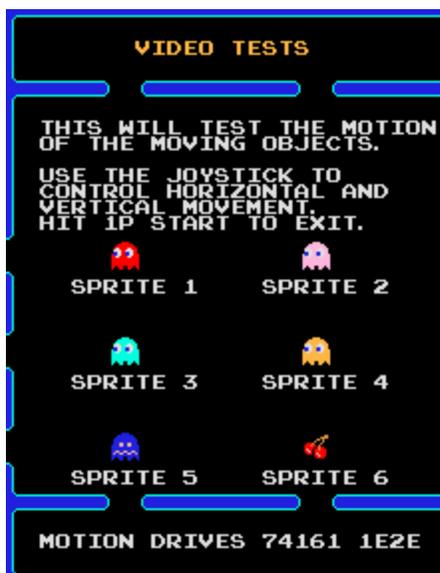
The test gives suggestions as to possible problems in particular RAMs.

- Be sure your Motion Object Location RAMs are functioning properly before running this test by executing the Sprite Location Test first.
- If the character appears in the right colors, but appears garbled (or is simply a square), check the 2532 chip at location 5F on the game board.

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Sprite Motion Test

Use this to test the motion of the sprites. Three rows of 2 sprites each appear on the screen. Moving the joystick will set the sprites in continuous motion. Pressing the 1P START BUTTON while in motion will return them to their home position. The test appears as follows:



The Sprite Motion Test - Home Positions



The Sprite Motion Test - Sprites in Motion

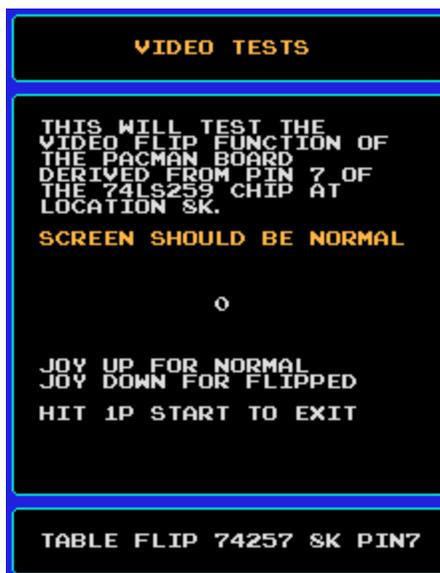
- As with the Sprite Color Test, be sure and run the Sprite Location Test before running this test to ensure that the Motion Object Location RAMs are working properly.
- The sprites should move smoothly in all **FOUR** directions.

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Video Flip Test

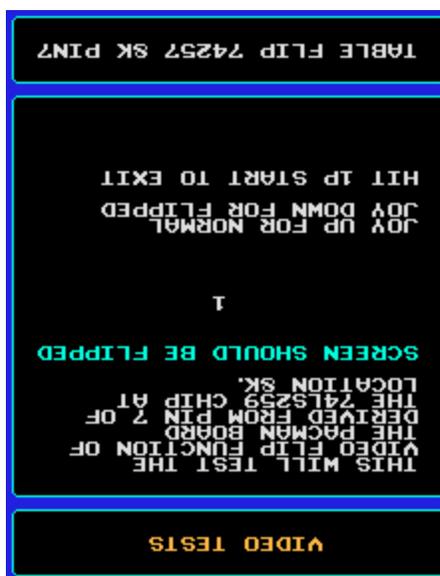
This will test the functionality of the flip circuits used during a two player game in a cocktail table.

In normal (non-flipped) mode, pin 7 of the 74LS259 at location 8K will be LOW. The screen should appear as follows:



The Video Flip Test in Normal Mode

Pressing the PLAYER ONE JOYSTICK DOWN will set pin 7 of 8K to HIGH, and look like:



The Video Flip Test in Flipped Mode

You may use the joystick to toggle between Normal and Flipped Mode.

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BURN-IN MODE

This mode may be set to ensure that the board will work for a long period of time without resetting. It is most useful if set after running all the other tests in the DIAGNOSTICS SOFTWARE.

- To enter BURN-IN MODE, flip the TEST switch into "TEST MODE" and reset the machine.
- Before entering BURN-IN MODE, be sure to run the DIAGNOSTICS SOFTWARE at least **ONCE** in NORMAL MODE. This will clear the number of resets and total running time.
- The only way to exit BURN-IN MODE is to flip the TEST switch into "GAMEPLAY MODE" and reset the machine.

The BURN-IN MODE relies heavily on interrupts, so be sure that the board passes the Interrupt Test.

The BURN-IN MODE Screen appears:

```
BURN-IN MODE
BE SURE THAT
ALL OTHER
TESTS HAVE
PASSED BEFORE
CONTINUING.

FLIP TEST
SWITCH AND
RESET FOR
NORMAL MODE.

NUMBER OF
RESETS
SHOULD BE 0.

RESETS-0

RUNNING FOR
0 HOURS
0 MINUTES
8 SECONDS

TOTAL TIME
0.0 HOURS
```

The BURN-IN MODE

- The line "RESETS-" indicates the number of resets that have occurred (intentional or otherwise) since first entering BURN-IN MODE. For a normal, properly working board, this number should be 0.
- Under the heading "RUNNING TIME" is the amount of time since the last reset, in Hours, Minutes, and Seconds.
- "TOTAL TIME" indicates the TOTAL amount of time that the board has been in BURN-IN MODE. The number is given in Hours, with each decimal value equal to 6 minutes (thus, "3.2 HOURS" implies the board has been in BURN-IN MODE 3 Hours, 12 Minutes). This value is kept in Scratch Pad RAM, so if an error develops this value may be corrupt.
- Once per minute, the screen will clear momentarily as the RAM Test is executed. If an error is found in the RAM, a message will be displayed on the left side of the screen indicating the RAM chip where the error was detected.

It is recommended that the operator execute all of the tests in NORMAL MODE, and then leave the board running for several hours in BURN-IN MODE to verify that it doesn't reset over time.

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If you read this whole manual and you are unsure of your ability to use the diagnostic kit, we invite you to [send us your game board](#) for a free repair estimate. We'll plug in the diagnostic kit and run the tests on our bench. Then we'll give you a call and tell you how much it would cost you to have us do the repairs.

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