INSTRUCTIONS FOR USE OF THE

PINBALL TESTER

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These instructions are designed to guide the technician in the use of our Pinball Tester, a powerful tool for troubleshooting all computerized pinball machines manufactured by Bally and Stern from the first electronic models introduced in 1977 through approximately 1984. Following is a partial list of these games:

BALLY PINBALLS

All of these games will run on the **Bally 2518-35** MPU board or the Stern MPU-200.

Early games will also run on the Bally 2518-17 or Stern MPU-100:

B.M.X. Baby	Fathom Fireball	Lost World	Mata Hari	$6 Million Man
Pacman Black Jack	Classic Fireball 2	Medusa Mr.&Mrs. Pacman		Skateball Space
Black Pyramid	Flash Gordon Freedom	Mystic Night Rider		Invaders Speakeasy
Centaur Cybernaut	Frontier Future Spa	Nitro Groundshaker		Spectrum Spy Hunter
Dolly Parton	Goldball Granny &	Paragon Playboy Power		Star Trek Strikes &
Eight Ball 8 Ball	Gators Harlem	Play Rapid Fire		Spares Supersonic
Deluxe Elektra	Globetrotter Hot	Rolling Stones		Vector Viking X's &
Embryon Evil	Doggin' Kings of Steel	Silverball Mania		O's Xenon
Knievel	Kiss			

STERN PINBALLS

All of these games require a U2 & a U6 chip and will run on the **Stern MPU-100**, MPU-200

or Bally 2518-17 or 2518-35 MPU boards. They all have 6 digit displays:

Stingray 'Pinball' Stars Memory Lane

Lectronomo Nugent Dracula Wyldfire

Trident Hot Hand Majic Genesis Shuffle

All of these games require a U1, U2, U5, & U6 and will ONLY run on the **STERN MPU-200**.

They all have 7 digit displays:

Ali Big Game Catacomb Cheetah

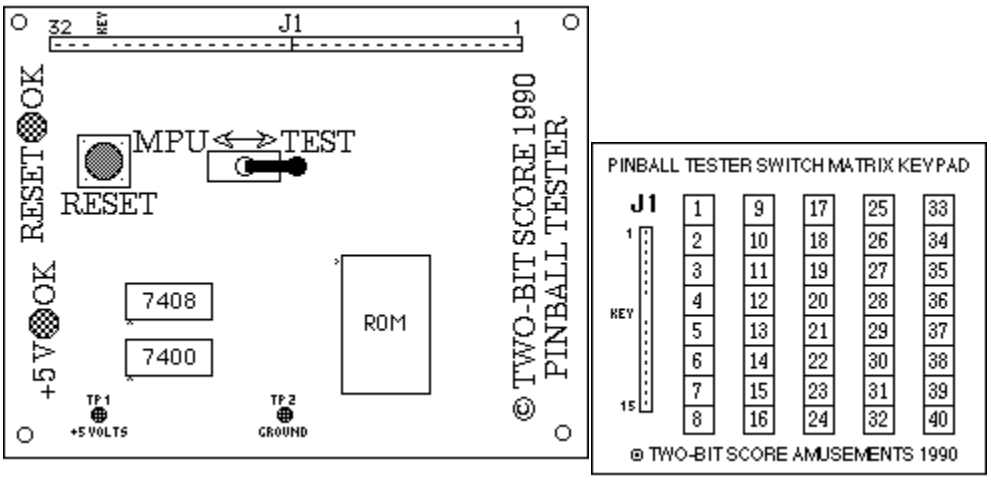
Dragon Fist Flight 2000 Galaxy Iron Maiden

Lightning Meteor Nine Ball Orbitor

Quicksilver Seawitch Split Second Star Gazer

Concept: The Pinball Tester allows the technician who is faced with an unknown CPU board to quickly determine whether there is a problem in it's software or hardware. Additionally, it allows him to exercise each component on the MPU and driver boards individually using the game as a test fixture.

GETTING STARTED: Included in your Pinball Tester should be: the two circuit boards pictured below, three connecting cables, a 2101 RAM (see page 7), and this manual. In addition you will need a Voltmeter and a Logic Probe (available from Radio Shack for around $20). Notice that the three cables provided all have 16 position connectors. Two of the cables will be used side-by-side to make the 32 position 'Tester to MPU J5' cable and the third will be used for the 15 pin 'keypad to MPU J2' cable. You are cautioned at this point never to plug these cables into any MPU board that has bent pins on it's connectors, nor one which has had wires soldered to these pins, as the springs inside the cable connectors will be destroyed! If this should happen, see DON'T PANIC on the last page of this manual.

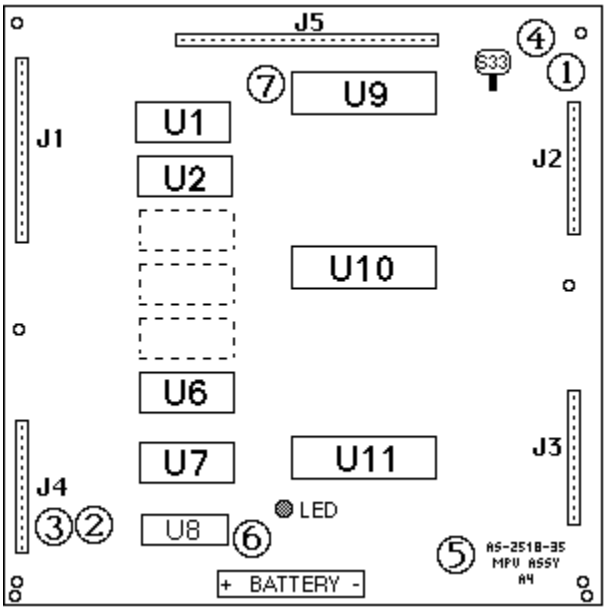


BEFORE YOU PLUG IN THE TESTER:

You should first do the following tests to assure yourself that the proper voltages are present on the MPU board and that there is no obvious physical damage. Visually inspect the MPU board for signs of battery leakage and resultant **CORROSION** at or near the battery. Pay particular attention to the U8 socket (under the 5101 RAM chip). If there is any sign of discoloration on the chips, sockets or circuit board, DO NOT plug in the TESTER until you repair the corrosion. TWO-BIT SCORE provides a board cleaning service which includes stripping bad components off the board, glass-beading (sand-blasting) the bare circuit board and replacing components. See the last page of this manual for details.Look carefully at the lower end of the J4 plug on the MPU where the Ground, +5, +12, and +45 Volts come onto the MPU board at pins 12 through 19. If there is any indication of arcing, (say a hole burned through the board

you can stick your finger through) DO NOT plug the TESTER into this board! You will blow it up! In most all cases where the J4 plug is burned up, every chip on the MPU will be found to be bad.

Next, get out your voltmeter and check for +5 Volts between Test Point 4 (Ground) and Test Point 1 (+5 volts) located in the upper right corner of the MPU. If absent, follow the path of the five volts back through the solenoid/regulator board to the unregulated 12 volt line coming from the transformer. Also test for 22 volts at MPU Test Point 3. If absent, check the solenoid fuse at the transformer board. Check for a minimum of +3 volts across the NiCad battery. If it is lower or there is ANY indication of leakage, or even if the date code on the battery is older than four years, REPLACE THE BATTERY. When all voltages are correct, you may proceed with hooking up the tester.



T TEST POINTS

	Voltmeter	Logic probe
TP1=	+5 Volts	High
TP2=	+13 Volts	Hi-Pulsing
TP3=	+22 Volts	Hi-Pulsing
TP4=	Ground	Low
TP5=	+5 Volts	High
TP6=	Trigger toggles Hi-Lo with LED	
TP7=	VMA	Hi-Lo Pulsing

WHETHER OR NOT YOU HAVE READ THE WARNINGS UNDER 'GETTING STARTED', TAKE THE TIME HERE TO VISUALLY INSPECT THE PINS ON J2 AND J5 OF THE MPU BEFORE YOU PLUG IN THE TESTER. IF THERE IS ANY SIGN OF DAMAGED OR CORRODED PINS, DO NOT PLUG IN THE CABLES! YOU WILL DESTROY THEM!

HOOKING UP: Open up the coin door and locate the 'TEST' pushbutton mounted on the inside of the door. Open the head to expose the circuit boards. Unplug the switch inputs from the MPU at J2. If you are working on a Stern game with connectors going to J5, unplug these also.

Place the PINBALL TESTER board face up in front of you and connect the cables from the TESTER to the MPU at J5. Be certain that pin one on the TESTER gets connected to pin one on the MPU. NOTE: It is possible to get the end of the cable for pins 1 through 16 reversed, as it is not keyed. ALSO: While the Bally -17 and Stern MPU-100 boards have exactly 32 pins at J5, the Bally -35 board has 33 pins and the Stern MPU-200 has 34. These extra pins numbered 33 & 34 are not used and are exposed when the cables are in place.

Flip the toggle switch on the TESTER board to the 'TEST' position.

Connect the Keypad to the MPU at J2. Notice that the cable going to J2 is keyed on pin 7 of 15 pins. This puts the key very near the middle of the connector: Don't plug it in upside down!

POWER UP THE GAME: If your MPU was dead before (the LED came on and just stayed on), but it flashes with the tester plugged in, one or more of your GAME ROMS is bad and will need to be replaced. See DON'T PANIC on the last page of this manual. If your board is still dead, read on:

WHAT SHOULD HAPPEN IS: The LED on the MPU board should flash seven times and then a 0 should begin flashing in the 'ones' digit of player 1-4 displays. The 0 stays on constantly in the Match/credit display. This 'IDLING MODE' is an indication that the MPU has passed all initial tests and is now running the test program stored in the ROM on the TESTER board. At this point, the MPU is not using the ROMs in locations U1-U6 and they need not be installed. If you have reached this point, skip down to the IDLE MODE. If not, read on:

If the LED flashes at least once, but not seven times, skip down to 'FLASHING LED'. If the LED comes on and stays on, make sure the toggle switch on the tester is in the TEST position and that all cables are connected properly. The TESTER works with all Bally AS-2518-17, AS-2518-35, AS-2518-133, Stern MPU-100 and MPU-200 boards. The tester works with all ROM, PROM and EPROM jumper combinations. If all appears to be in order and the LED stays on constantly, try a complete set of known good 'plug-in' chips; that is; U7, U8, U9, U10, & U11. If you now have flashing at power up, try flipping the switch on the TESTER to MPU and press and release the RESET button. If you do not have flashes with the GAME (MPU) ROMS, but you do have flashes with the TESTER (TEST) ROM program, your GAME ROMs are probably bad. See DON'T PANIC on the last page.....

If you still don't have any LED flashes, get out your logic probe and set it's TTL/CMOS switch to TTL and the Pulse/Normal switch to Pulse. Connect the black and red power leads from the logic probe to a convenient +5 Volt source; Use either

Ground and Test Point 5 on the MPU board or the test points 1 & 2 provided on the TESTER. Then confirm the following functions of the MPU:

(If at any time you get one or more flashes, skip down to FLASHING LED.)

RESET: Touch the probe to U9 pin 40, the RESET line. It should be low at power up and go high within one second. If it does not go high, replace the reset transistors Q1 and Q5 (a 2N3904 & a 2N3906). Do not proceed until the reset line is high.

CLOCK and BUFFERS: Touch the probe to U9 pin 3, the **Clock-One** signal. The probe should indicate a high frequency pulse. If absent, follow the signal back through the buffer (MC3459) at U15 to the clock generator (9602) at U16. If necessary, replace these chips. If you are already lost, **DON'T PANIC!** Go to the last page of this manual for some painless alternatives.

NOTE: ALWAYS PUT A SOCKET IN PLACE OF THE OLD CHIP! NEVER SOLDER A NEW CHIP TO THE CIRCUIT BOARD! These boards were not designed for repeated replacement of components; they were designed to be built quickly and inexpensively. If the chip blew once, the odds are you'll be back someday. Installing a socket will also allow you to remove the chip easily when doing diagnostics in the future. Do yourself a favor. Put it on a socket now.

If the Clock-One signal is present, check for the **Clock-Two** signal at U9 pin 37. Once again the probe should indicate a high frequency pulse. When both clock pulses have been confirmed check for;

VALID POWER: Touch the probe to U10 pin 18. The probe should indicate a pulsing signal. If absent, follow the valid power signal beginning at Test Point 3 and running through the gates at U14. If necessary, replace the chip at U14 WITH A SOCKET and a new chip.

DISPLAY INTERRUPT TIMING: Touch the probe to U11 pin 40. The probe should indicate a pulsing signal. If absent, follow the blanking signal beginning at the (555) clock generator U12 pin 3 and ending at U11 pin 40. If necessary, replace the chip at U12. Yes, they do make 8 pin sockets.....

VMA GATING: Touch the probe to U9 pin 5. Hold the logic probe in place and press and release the RESET pushbutton on the TESTER. When the RESET pushbutton is released, the probe should indicate a series of different signals; pulsing then not, then pulsing again. If shorted high or low, check for shorts at the gate used to drive the variable memory address at (4011) U19 pins 8, 9 &10.If you are still dead, remove the MPU from the game and do a visual inspection for these commonly

overlooked problems: A chip has been inserted into it's socket incorrectly and one or more pins is sticking out or is folded under the chip. Sight along the chips sideways from a low angle to look for pins out of line. If the MPU has been out of the game recently, look for solder splashes on either side of the board. Look for scratches on the board which may have been caused by rough handling and have cut through a trace. Most important, look for signs of corrosion under a socket where it may be hidden and causing shorts. If all this fails to provide an answer, get out your ohmmeter and look for shorts between address and data lines and Ground or +5 volts.

FLASHING LED

OBSERVE the TESTER board: The two green LEDs are both lit, indicating that Five volts is present and that the reset line is high, as it should be. Press and hold the reset button on the TESTER board. Note that the RESET LED on the TESTER goes out and the LED indicator on the MPU stays lit. If the MPU LED will not light under these conditions, probe TP6. It should be high when the LED is out, and tri-stating (no signal) when the LED is lit. When the button is released, the MPU begins to go through it's seven flash power-up sequence again. This is the preferred way to do a 'RESET' rather than switching the game on and off. It is necessary to do a RESET whenever the MPU-TEST switch on the tester is toggled. This switch enables either the resident program at U3 on the TESTER or the GAME ROMs on the MPU. When the MPU-TEST switch is in the TEST position, the MPU ROMs are disabled, and it does not matter whether they are installed on the MPU board or not.

When you first power up the game, it takes a half-second for all of the components on the MPU to get up to full power. The result is a flicker of the LED before the first flash. When the RESET button on the TESTER is pushed and released, the program starts immediately. The LED flashes precisely the number of times it should with no flicker before the first flash. As the MPU runs the program in ROM memory, in both the TEST and the GAME program, it does a series of self tests and returns a flash of the LED as an indication that each test has been passed. By noting how many flashes occur before lock-up, you can tell which component failed during testing. Here are some guidelines as to what the computer was trying to do at the time it crashed:

AFTER ONE FLASH: The MPU was testing the 6810 RAM at location U7. Assuming that you have already replaced the 6800 at U9 and the 6820 (or 6821's, a faster equivalent chip) at U10 & U11, try a new U7. While you have the old chip out, take a close look down into the empty U7 socket. Look for discoloration or obviously bent pins. If a new 6810 doesn't get you past one flash, Use the logic probe to check the gate at U18 pins 14 and 15. This is the select gate for U7 and it should pulse when the 6800 (CPU) wants to read the RAM at U7. If you find input at pin 14 but no output on pin 15, replace U18.

AFTER TWO FLASHES: The MPU was testing the 5101 CMOS RAM at U8. This particular chip is very 'static sensitive' and can be destroyed by handling it if you have any electrical charge on your body. This risk can be reduced significantly by touching one hand to the ground braid of the game when handling the 5101.

As an aid to repairing these boards, you should always carry your 2101 RAM chip. It is a pin-compatible device to the 5101, and you may find a few spares on your old video game boards. The advantage to the 2101 is that it is not static sensitive and may be handled incautiously without fear of damage.

The disadvantage is that (unlike the 5101 which uses almost no power in it's 'stand-by' state) the 2101 will kill your NiCad battery if it is left on the board after repairs are completed. Always remember to replace the 2101 with a known good 5101 before returning the game to service. *Note: Some manufacturers use the designation 9101 interchangeably with 2101.*

If you are certain that the chip in U8 is good and that it is seated in a good socket, but you are still stuck at two flashes, probe U18 Pins 7 and 6. This is the gate which selects the 5101 at the proper time. If you find output at pin 6, probe the following gates: at U17 pins 9 & 10 input and 8 output; at U18 pin 11 input and 12 output; and two gates at U19 pins 1 & 2 input and pin 3 output as well as pins 12 & 13 input and 11 output.

AFTER THREE FLASHES: The MPU was testing the 6821 at U10. Try a new one. If that doesn't help, probe U10 pins 2 - 9 while holding down the RESET button. All should be high. If any are low, look for a short to ground. Remove the U10 chip during short testing if necessary. If a new 6821 doesn't get you past three flashes, use the logic probe to check the gate at U17 pins 4, 5 & 6. This is the select gate for U10 and it should pulse when the CPU wants to read the inputs to the PIA at U10. If you find input at U17 pins 4 & 5, but no output on pin 6, replace U17.

AFTER FOUR FLASHES: The MPU was testing the 6821 at U11. Again, try a new one and then probe U11 pins 2 - 9 while holding down the RESET button. All should be high or tri-state. If any are low, look for a short to ground. Remove the U11 chip during short testing if necessary. While it is unlikely to be a gating problem, as the two PIA's are selected by the same gate at U17 discussed in 'three flashes' above, you should confirm continuity between U10 pin 23, U11 pin 23 and U17 pin 6.

AFTER FIVE FLASHES: The MPU was testing the Interrupt Generator circuit at U12. Look for pulsing at the output from U12 at pin 3 and continuity to U11 pin 40. Confirm continuity between U9 pin 4 and U11 pins 37 & 38. Hold down the reset button; U9 pin 4 should remain high or pull-up resistor R134 may be bad. In reset

U20 pin14 should be low, not pulsing; U19 pin 3 should be low, not tri-state. Check that the gate at U17 pins 4, 5 & 6 (which select the PIAs U10 & U11) read: pin 4 low, pin 5 low, and pin 6 high while held in reset and all 3 pulse when the reset button is released.

AFTER SIX FLASHES: The MPU was testing to see that there is power to the solenoids in the game. This is accomplished by bringing solenoid voltage (+45 volts!) onto the MPU board, through a resistor (R113) which drops it to approximately +22 volts (read at Test Point 3), and then through three separate gates at U14 (4049 or a 4572 on the MPU-200) and eventually to U10 pin 18 as a constant 'low pulsing high' signal. If this signal is absent, the CPU thinks that there is no power to the game solenoids and will not proceed with power up. The most common cause for six flashes is a blown solenoid fuse and this should be explored first.

AFTER SEVEN FLASHES: There are some cases where the MPU flashes 7 times and then does nothing or does something strange. If you have a frequency counter, be certain that the 555 output (on pin 3) is within about 20% of 450 MHZ. Also:

The following game will flash seven times and then stop until switches #28, #29, and #30 on the switch matrix are held closed. Bally: Fireball Classic

The following games will flash seven times and then stop until either switch

#1 or #2 on the switch matrix is held closed. Bally: Centaur, Elektra, & Vector

The following games will flash seven times and then stop until any two switches numbered 1 through 5 are held closed. Bally: Fireball 2, & Fathom

The Bally game Six Million Dollar Man will flash seven times and lock up if dip switch 31 on the MPU is turned on at power up.

Bally AS-2518-133 Boards (the combination Pinball/Video games Baby Pacman and Granny & the Gators) may be tested in any pinball machine, but will stop after six flashes with the game software. The board will behave as a normal pinball with the tester attached and the TEST ROM selected. ***NOTE: The only difference between the -35 and the -133 board is that the -133 has a diode in place of the 2 K[[Omega]] resistor at R113 on the -35.***

Interesting Trivia about the Stern MPU-200 board:

Many Stern MPU-200 games will flash seven times and then continually pulse solenoids (looking for all the balls) until switches #33 , #34, and #35 on the switch matrix are held closed (or for seven cycles of solenoid firings).

If you power up an MPU-200 with all 32 dip switches turned off (open), it will flash seven times and jump directly to test mode.

When you down-grade an MPU-200 to run an MPU-100 game, you can remove jumpers 32-33 and 34-35 and remove the upper 5101 chip.

The MPU-200, when jumpered for four 2716 EPROMS (U1, 2, 5, & 6) will run Bally three 2716 (U1, 2, & 6) games. To run Bally two 2716s (U2 & U6), change 13-14 to 13-15 and change 5-7 to 1-5.

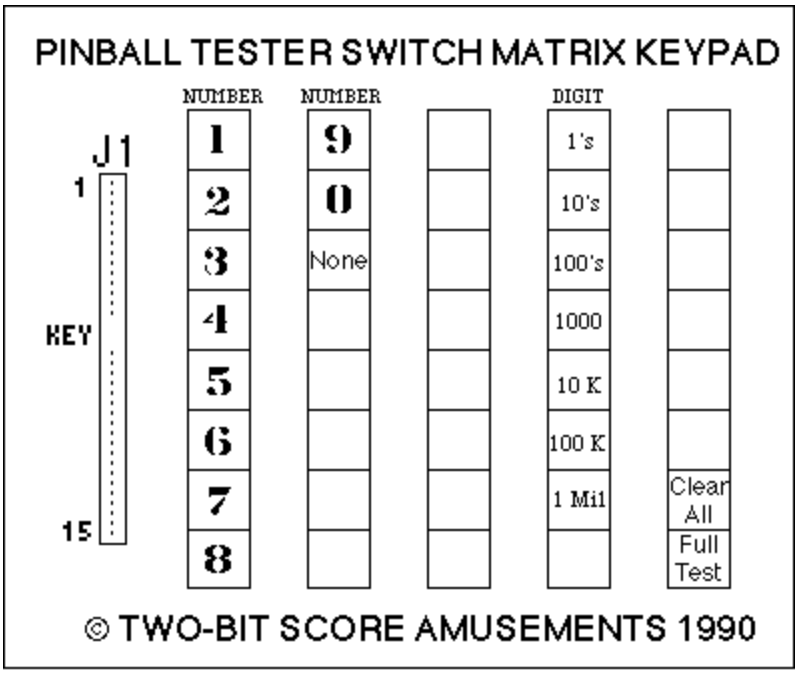
IDLE MODE

With the 0 flashing in player 1 - 4 displays you are ready to begin testing the individual inputs and outputs of the MPU. Locate the red TEST pushbutton on the inside of the coin door. Press the button once to enter the display test.

DISPLAY TEST

The match/credit display now reads 1. Player 1 - 4 displays are blank. You may drive any digit with any number, 0 through 9 or blank by entering the number you wish to display into switches 1 through 11 and set the digit you wish to drive with switches 25 through 31. Pressing the Full Test button will start a counting sequence which puts all ten numbers in first digit one, then one and two, then one, two, and three, and so on until all digits are driven. Press the Full Test button again to return to the individual digits test.

Use the chart below as a guide to the use of the keypad during the Display test.



If any digit or segment is found to be missing from only one display, it is probably the fault of that display; substitute a different display to confirm.

If any digit is found to be missing from every display, probe the seven outputs from the PIA at U11 pins 3 through 9 and follow the signals to J1 pins 1 through 7. During the full test they should all be low pulsing high.

If any segment is found to be missing from every display, probe the outputs from the PIA at U10 pins 6, 7, 8, & 9 for pulsing BCD data and follow the signals to J1 pins 25, 26, 27, & 28. All should be low pulsing high.

If random garbage is displayed, suspect the 5101 or the 4502 at U20. Note that the PIA at U10 pin 2 through 9 are used to generate the switch strobes, read the dip switches, drive the lamps, as well as to drive the displays. Shorts in these other circuits will cause strange display outputs, and repairs should be postponed until all other tests are passed.

When all displays are confirmed as working, press the TEST pushbutton to advance to the Lamp Test.

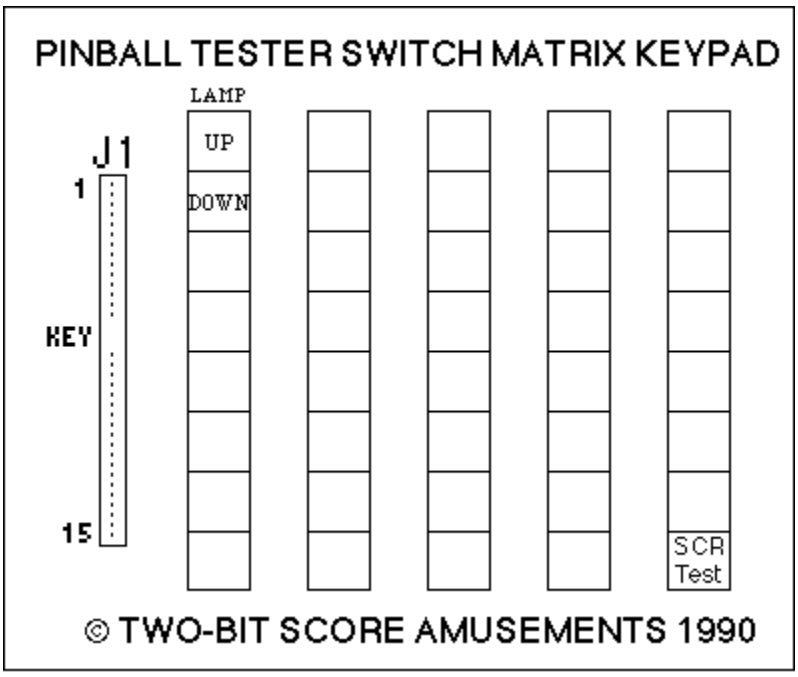
LAMP TEST

The match/credit display now reads 2. Player 1 - 4 displays are blank. The program automatically begins to drive all of the feature lamps. First each column, one at a time, then each row, one at a time are driven. This will continue until you either press the

TEST pushbutton on the front door to go to solenoid test, or the SCR button on the Keypad. If any controlled lamp should fail to light, press the SCR test button. This will allow you to exercise any one SCR (drive transistor) on the A5 lamp driver board.

When the UP button is pushed and held, the MPU will begin to flash the lamps in number order from one through sixty. Press the 'up' button to advance to the next higher number. Press the 'down' button to go backwards. Release the buttons at any time to stop on a particular lamp and it will remain energized. Press and hold to continue counting. Note that the displays show the **'Q'** number assigned to the SCR being driven as each lamp is flashed. Consult the chart provided in the schematics that came with your game for the location of the lamp corresponding with each SCR.

Use the chart below as a guide to the use of the keypad during the Lamp test.



If a large number of lamps are not functioning, and you have confirmed that the bulbs are good and receiving power, look for signal being generated at PIA U10 pins 2 - 9 and continuity to J1 pins 12 - 19.

When all lamps are confirmed as working, press the TEST pushbutton to advance to the Solenoid Test.

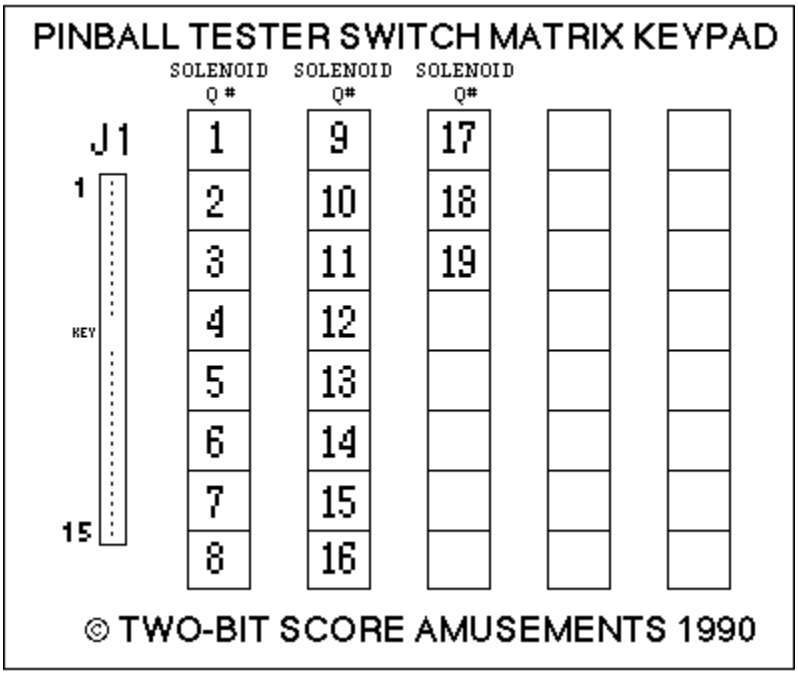
SOLENOID TEST

The match/credit display now reads 3. Player 1 - 4 displays are blank. When any numbered button on the keypad is pushed, the MPU will pulse the selected drive

transistor (located on the A3 Solenoid/regulator board) four times. Press another button to test a different solenoid. Note that the displays show the **'Q'** number of the transistor being driven as each solenoid is pulsed. Consult the chart provided in the schematics that came with your game for the location of the solenoid corresponding with each transistor.

Keep in mind that not every drive transistor is assigned in every game and that seven digit Bally games which use a solenoid expander relay will not be able to test the solenoids on the 'active' leg of the relay.

Use the chart below as a guide to the use of the keypad during the Solenoid test.



If one or two solenoids do not fire, confirm continuity by shorting the head of the appropriate drive transistor to ground with a jumper wire. This should fire the coil. If not, either there is a lack of continuity between the transistor and the coil or else there is no power getting to the coil.

If only the knocker and coin door coils fire, but none of the playfield coils work, the fuse hidden on the underside of the playfield is blown.

If a few random coils are not working, or if the wrong coils are firing, probe for BCD (binary coded data) pulsing at pins 10 - 13 of the PIA at U11. Follow the signal to J4 pins 1 - 4; All four are normally low and go high for an instant when triggered.

If an apparently random number of coils do not appear to have power getting to them, keep in mind that the power is 'looped-through' each coil, and that if there is a break in the path, none of the coils down the line will get power. The break may well be at a coil that works! Look over the solder joints at all the coils.

When all solenoids are confirmed as working, press the TEST pushbutton to advance to the Stern SB Test. This is a detailed test for exercising Stern SB-100 and SB-300 Sound boards in a game that has a known good MPU but has sound problems. If you are working on a Bally game, press the TEST button again to enter BURN-IN MODE and skip the next two pages.

STERN SOUND BOARD TEST

In order to use this test, it is necessary that you have a spare Bally AS-2518-35 board with the following jumper combination:

E7-E8, E9-E13, E12-E35 and E11-Ground

Save this board for future use. With the TEST ROM installed in U2 and no other ROMs installed it is very handy for testing the power supply and driver boards of any unknown Bally or Stern pinball which is lacking only an MPU board.

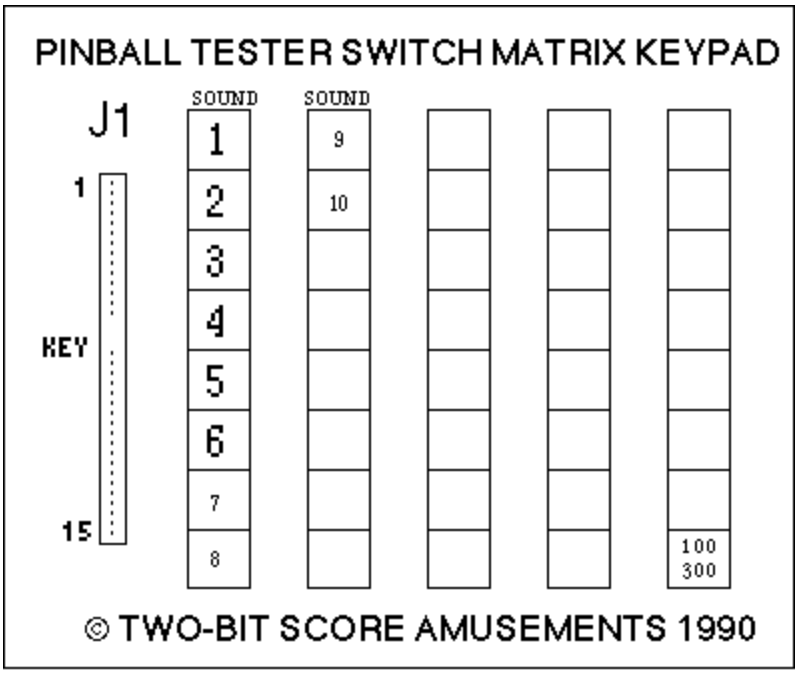
Carefully remove the PINBALL TESTER ROM from the TESTER board at location U3. Install it in the 2518-35 board at location U2 and exchange the 2518-35 for the MPU in the Stern game which has the sound board you wish to test. Plug in cables at J1, 2, 3, 4, & 5. Power-up and the MPU will flash seven times and come up in the IDLE MODE described above. Press the TEST button on the coin door to step through the tests until you get to the SOUND TEST. Player 1 - 4 displays are blank. The match/credit display now reads 4 100. This is an indication that you are ready to test an SB-100 board. Press the 100-300 button to choose the type of board you are testing.

SB-100

When testing an SB-100, the first ten keypad buttons cause the MPU to send a signal to the sound board via the J5 cables to make one of ten different sounds.

Some SB-100 boards do not have a U5 chip. These boards only use sounds 1 - 6.

Use the chart below as a guide to the use of the keypad during the SB-100 test.

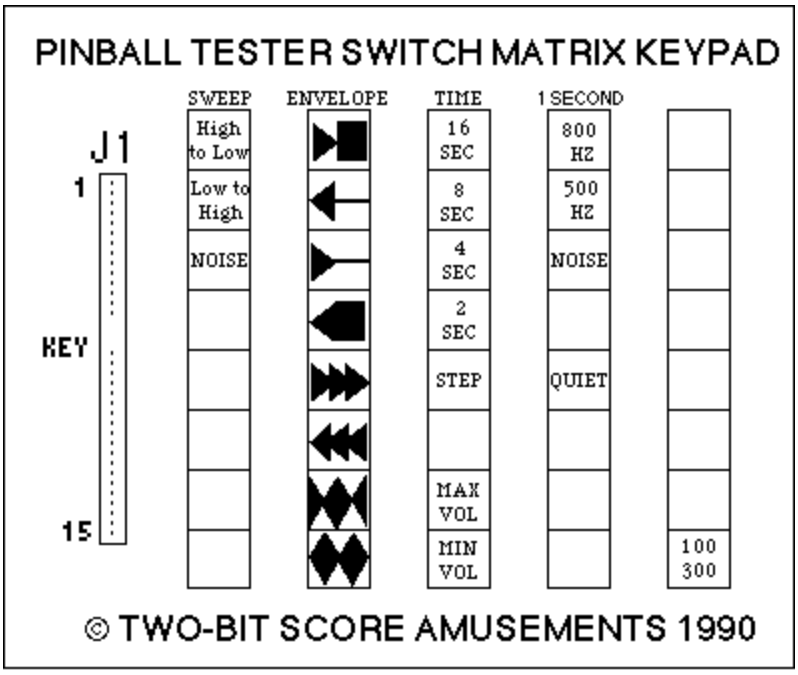


If you are working on an SB-300 Sound board, press the 100-300 button to enter the SB-300 test mode.

SB-300

The SB-300 test is initiated by choosing first a 'sweep' from high to low, low to high or noise. Next, select an 'envelope' or sound pattern; then a 'time' duration. This will cause the MPU to send a signal to the sound board via the J5 cables to make the appropriate sounds.

Use the chart below as a guide to the use of the keypad during the SB-300 test.



At any time you may press the TEST pushbutton to advance to the Burn-In Test which will exercise many sounds automatically as it runs.

BURN-IN TEST

This final test is a combination of all previous tests and is included as a way of running the MPU and driver boards under full load for a period of time to be certain that there are no problems which occur only after the boards heat up. Once the Burn-In test is initiated, the MPU will send commands to energize each solenoid, flash all the lamp rows and columns, and drive all the display digits. You can freeze the action by pressing switch #40 and restart by pressing switch #1.

If you are testing a Stern Sound board, press switch 1 on the keypad for SB-100, switch 2 for an SB-300 and any switch 3 through 40 to temporarily halt the test sequence. Press 1 or 2 to start again.

At any time you may press the TEST pushbutton to return to the IDLE MODE.JUMPER COMBINATIONS for BALLY MPUs

To run the devices on the board indicated, connect these jumpers and no others.

Connection points on the circuit board all have the prefix "E".

BALLY 2518-17 MPU or STERN MPU-100 WITH:

9316A in U2 9316A in U6 = 1-2, 3-4, 6-7 *Note: Stern ROMs labeled "25A-ROMP#" are 9316A's.*

2716 in U2 9316A in U6 = 1-2, 3-4, 6-7 PERFORM THE FOLLOWING MODIFICATION:

Component side of board: Cut the trace from {U2 pin 18} to {U3 pin 18} where it passes between sockets U2 & U3. Solder side of board: Run a jumper from {U2 pin 18} to {U17 pin 11}. Cut the trace going to {U2 Pin 21}. Jump from Pin 21 to Pin 24 (+5 Volts) on U2.

2716 in U2 2716 in U6 = 1-2, 3-4, 6-7 PERFORM THE FOLLOWING MODIFICATION:

Component side of board: Cut pin 4 away from U18;

Solder side of board: Short pin 4 to pin 5 on U18 with a solder blob; Cut the trace at Pin 21 on both U2 & U6. Run a jumper from Pin 21 to Pin 24 on both.

BALLY 2518-35 MPU WITH:

*Note: When connecting jumper **13A to 14 or 19**, be certain to cut **13-15**.*

9316A in U1 9316A in U2 9316A in U6

1-4, 2-6, 7-8, 9-11, 12-36, 13-15, 16A-19, 31-32, 33-34

9316A in U1 9316A in U2 2716 in U6

1-4, 2-6, 7-8, 9-11, 12-36, 13A-19, 16A-18, 31-32, 33-35

No U1 2716 in U2 9316A in U6

1-5, 2-4, 7-8, 10-12, 11-29, 13A-14, 16A-19, 31-32, 33-34

No U1 2716 in U2 2716 in U6

1-5, 2-4, 7-8, 10-12, 11-29, 13A-14, 16A-18, 31-32, 33-35

2716 in U1 2716 in U2 2716 in U6

1-5, 2-4, 7-8, 10-12, 11-25, 13A-14, 16A-18, 31-32, 33-35

2716 in U1 2716 in U2 9316A in U6

1-5, 2-4, 7-8, 10-12, 11-25, 13A-14, 16A-19, 31-32, 33-34

2716 in U1 2716 in U2 2532 or 9332 in U6

1-5, 2-4, 7-8, 10-12, 11-25, 13A-14, 16A-34, 29-33, 31-32

No U1, 2532 or 9332 in U2, 2532 or 9332 in U6

4-12, 7-8, 10-11, 13A-14, 16A-34, 29-33, 31-32

No U1, 2532 or 9332 in U2, 2732 in U6

4-12, 7-8, 10-11, 13A-14, 16A-29, 31-32, 33-35

JUMPER COMBINATIONS FOR STERN MPUs

Note: Stern ROMs labeled "25A-ROMP#" are 9316A masked ROMs. Chips with a 'window' on top are 2716 EPROMs. Both chips contain the same program, but they are selected differently, requiring that the proper 'jumpers' be connected on the MPU board to match the device type.

To run the devices and the board indicated, connect these jumpers and no others:

STERN MPU-100 or BALLY 2518-17 MPU with:

9316A in U2 9316A in U6 = Make jumpers 1-2, 3-4, 6-7 with no modifications.

2716 in U2 9316A in U6 = Make jumpers 1-2, 3-4, 6-7 and do the following modifications:

Component side of board: CAREFULLY cut the circuit trace running from {U2 pin 18} to

{U3 pin 18} where it passes between sockets U2 & U3.

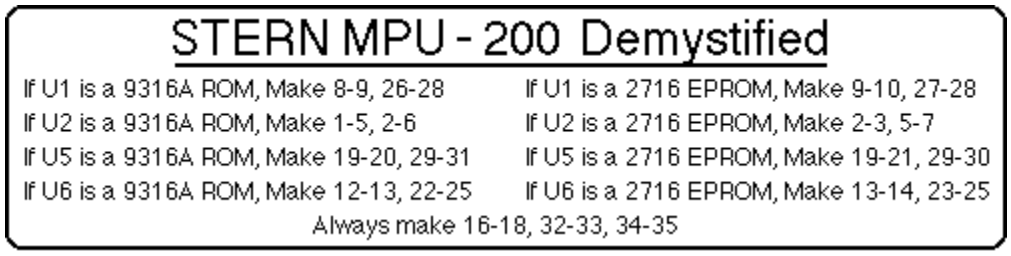
Solder side of board: Run a jumper from {U2 pin 18} to {U17 pin 11}. Cut the trace going to

{U2 Pin 21}. Run a jumper from {U2 Pin 21} to {U2 Pin 24}.

2716 in U2 2716 in U6 = Make jumpers 1-2, 3-4, 6-7 and do the following modifications:

Component side of board: With a fine cutter, snip pin 4 away from the chip body of U18;

Solder side of board: Short pin 4 to pin 5 on U18 with a solder blob. Then, on both U2 & U6, cut the trace at Pin 21 and run a jumper from Pin 21 to Pin 24.



Therefore, to run a STERN MPU-200 with:

2716's in U1, U2, U5, and U6 (Do Not Use 36, 37, or 38) Connect:

2-3, 5-7, 9-10, 13-14, 16-18, 19-21, 23-25, 27-28, 29-30, 32-33, 34-35

Some interesting observations about STERN's GAMES

*The MPU-200, when jumpered for (4) 2716 EPROMS (U1, U2, U5 & U6), will run

Bally (3) 2716 (U1, U2 & U6) games with no alterations; and:

*To run Bally (2) 2716 games (U2 & U6), change 13-14 to 13-15 and change 5-7 to 1-5.

*If you power-up an MPU-200 with all 32 dip switches turned off (Open), it will

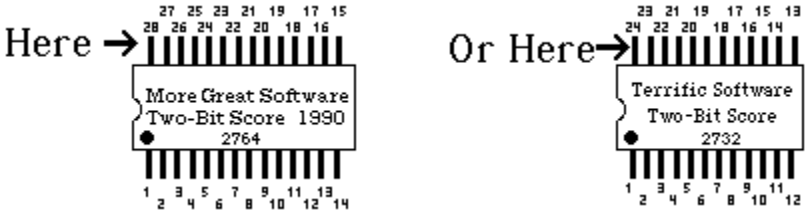
flash 7 times and jump directly into self-test, skipping the 'game-over' mode.

*To use a Stern 7-Digit score display in a Bally game [or vice-versa], solder pins 11 and 12 together and move the score display mounting bracket to the inside of door.

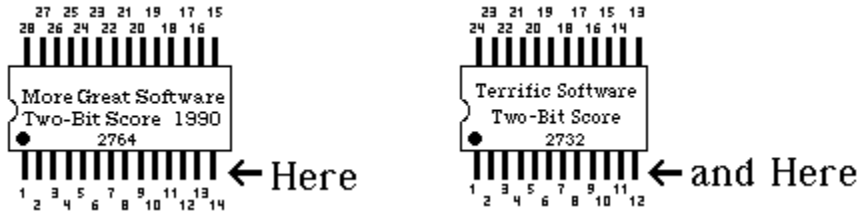
A Short Discourse on Polarity

EPROMS (Erasable Programmable Read-Only Memories) and indeed most all DIP (Dual In-Line Package) Integrated Circuit chips have one thing in common; the

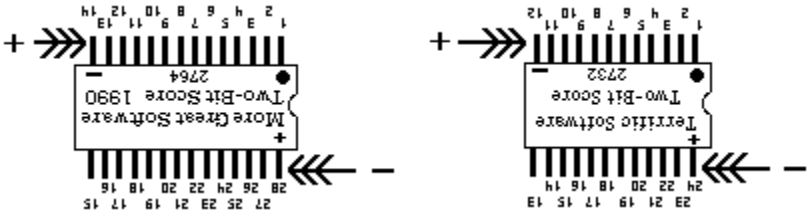
positive and negative power arrives at the chip in two opposite corners. The Positive (+ 5 Volts) is delivered to the highest number pin.



The Negative (Ground) is delivered to the pin in the OPPOSITE corner!



If you do not observe the polarity when you plug in the chips, you will deliver negative voltage directly to the positive pin, and positive voltage to the negative pin.



Turning on the power under these conditions even for an instant will DESTROY the chip! The EPROM will light up like a #47 Bulb for about two seconds, and then go out... Permanently! So don't rely on the direction of the PRINTED LABEL on the chip, it can be stuck on either way at the time of programming. Look for the notch at the end of the chip where pin number one is located. Be certain that this notch is facing in the same direction as the chip you removed, the same direction as all the other chips on the board! Exercise caution when inserting pins into socket holes; don't push down until you are sure that all the pins are going in smoothly and none are bending!

DON'T PANIC

If you should plug in the test chip backwards, or break off a pin, or if your PINBALL TESTER should be struck by lightning, or it should simply cease to function for you

for any reason, return it to TWO-BIT SCORE to receive a replacement or a repair for a nominal charge. Call for details.

If at any point in your diagnostics, you require assistance, you are welcome to call us for help. In addition, we provide FAST repair of circuit boards sent to us for repair. Boards are inspected upon arrival, and we call you within 24 hours with a firm estimate. We further guarantee that the cost of repair to any board will be less than our advertised price of a replacement board. {If you don't like the estimate, we will return your board immediately and pay the return shipping - you pay nothing for the estimate!} Upon receipt of authorization, repairs are made promptly and your boards are returned UPS Blue label (second day delivery). In most cases this entire process takes just one week! And if you need one, we have BRAND NEW MPU boards for all the games covered by this tester!

If it turns out that your software is at fault, or if you wish to move a CPU board from one game to another and you need the game ROMs to go with the new game, give us a call. We will install new software on your good working CPU board and thoroughly test it for only the cost of the ROMs. All of the games in the list on page one are available, as well as the GAMEROMS for all makes and models of electronic Pinballs.

If you found this to be a useful tool, be advised that we also sell a Test Chip which covers all Williams Pinball games with System 3, 4, 6 or 7 CPU's (1978-1984), Level 9 CPU's (1984-1986), and Level 11 CPU's (1986 - present) and one for all DATA EAST Pinballs, as well as many other interesting programs for coin-operated amusements. Give us a call anytime!

Your comments and suggestions are welcome.