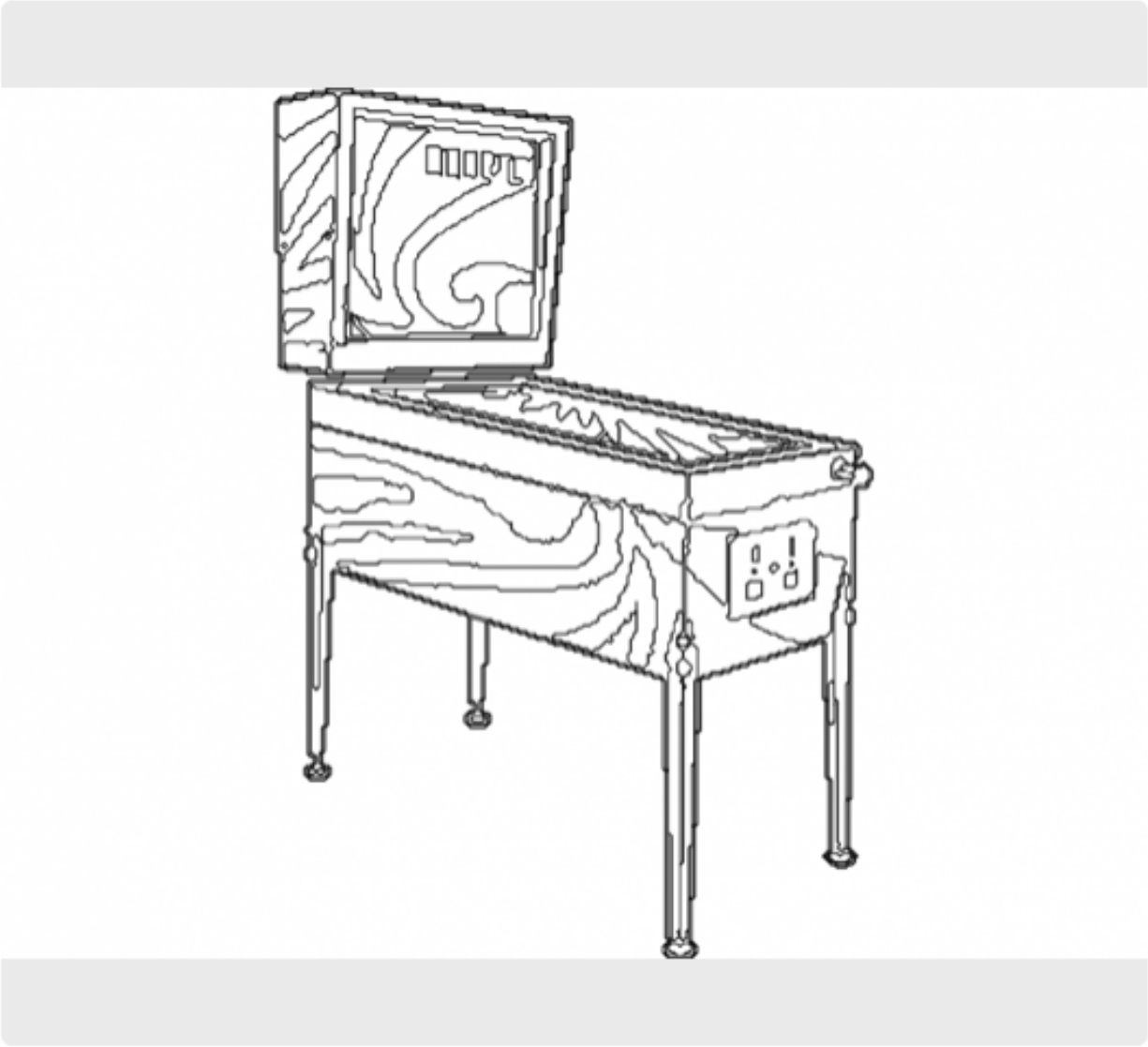
Pinball Test Unit



Arduino Version 2001.01

from Dave's Think Tank

Pinball Test Unit – Software Version 2001.01

The new Pinball Test Unit (PTU) from Dave's Think Tank improves tremendously on the self-tests of any pinball running a Bally AS-2518-17, AS-2518-35, Stern MPU-100, Stern MPU-200, or Alltek replacement MPU board. What kind of improvements are we talking about? Instead of just running through the solenoids over and over, the solenoid test now allows you to stop on and repeatedly fire a single solenoid, then stop it from firing while you make adjustments, then start it up again. It will tell you if vibration from a solenoid is setting off a switch. Similar improvements can be found in the switch test: fixing bouncing switches and even switch matrix errors just became a breeze! Not to mention new tests like the DIP switch review. There's lots to discover, so let's get started!

Getting Started

The PTU requires a Bally/Stern Arduino Pinball Adapter (the Arduino) to run. There are various ways to set up the Arduino, depending primarily on if you have purchased the Arduino to be used as a standalone test unit, or if you intend to use one that is already installed in a pinball and running the game on that machine.

The steps required by the various options will be laid out below. One thing you must know, however – if the Arduino is to be used as both a test unit and a game MPU, YOU MUST HAVE SOFTWARE FOR BOTH THE PINBALL TEST UNIT AND THE GAME! This is because, when you compile the software code onto the Arduino, it erases any existing program from the Arduino. You can easily switch between two programs, but ONLY IF YOU HAVE THE SOFTWARE FOR BOTH!

Fortunately, most of the Arduino code for pinball machines is available for free on the internet. If you can't find it, try contacting the dealer who sold you the Arduino – they must have it and should be able to get you a copy!

So, let's see what's required to set up a Pinball Test Unit!

Purchasing an Arduino as a Standalone Pinball Test Unit

If you purchase an Arduino to be used as a PTU, and only as a PTU, you can easily move it around between any pinball machines you own that have a Bally AS-2518-17, AS-2518-35, Stern MPU-100, Stern MPU-200, or Alltek replacement MPU board. The following steps will erase your Arduino, and then set it up as a standalone PTU:

Purchase Arduino: https://pinside.com/pinball/market/shops/1304-roygbev-pinball/by-game/185-flash-gordon

The Arduino can be purchased pre-programmed for a number of different pinball games. If you do not intend to use the game software though, it doesn't matter what game comes with it, as it will be written over. The Arduino itself must be a Mega 2560 Revision 3 or better, though.

Purchase the Arduino Integrated Development Environment (IDE): https://www.arduino.cc/en/software
(Free, but why not pay them a few bucks?)

Create a folder on your computer named PinballTestUnit. Download the PTU software from https://github.com/DavesThinkTank/PinballTestUnit to this folder.

Plug the Arduino into a USB port on your computer with an appropriate cable. You need a cable with a USB micro connector on one end, and a USB A or C on the other end, whichever your computer needs.

Make sure the "Switch" pins on the Arduino are connected with a jumper.

Open the file PinballTestUnit.ino (in the PinballTestUnit folder) with the IDE by double-clicking on it, or by running the IDE and selecting it using the File menu.

Click on the Verify checkmark (top left of the IDE screen) to verify that the software compiles properly. Any errors encountered will appear in red, in the black area at the bottom of the screen. There should be no errors in this step.

Click on the white box to the right of the checkmark. Click on "Select other board and port". Select "Arduino Mega or Mega 2560", and the port your Arduino board is plugged into.

Click on the Upload arrow (beside the checkmark) to compile the software and upload to the Arduino. Again, any errors will be displayed in red, in the black area at the bottom of the screen. You will need to deal with any errors before proceeding to the next step. If you have error messages, check that you have a jumper on the “Switch” pins. check your cable and connections. Check the board and port selections made above. Check if your computer’s firewall settings are interfering with the port.

Once the program has compiled and completed uploading, unplug the Arduino from your computer.

TURN OFF your pinball machine! Make sure the "Switch" pins on the Arduino are connected with a jumper. Install the Arduino into your pinball as per instructions included with the device.

When you turn on the pinball, the first thing you should see is the version number; 2001 in the player 1 display, and 01 in the credit window. This will last for about four seconds. If you don’t see this, you haven’t got the software running yet!

You can now proceed to the section below titled “Arduino Setup”, and run the tests on your pinball. Once you have tested one machine, you can remove the Arduino and install it in another machine to be tested. Once you have tested all machines you intend to test, the Arduino can be removed and stored. Alternatively, you can simply remove the “Switch” jumper, and the pinball will ignore the Arduino, and run the game. Place the jumper on a single pin of the Arduino so you do not lose it.

Using an Arduino as both a Pinball Test Unit and a Game MPU

Software is available to run many early Bally and Stern pinball machines using an Arduino. It is easy to switch between using your Arduino as a game MPU, then run it as a test unit, then change it back to a game MPU. But, YOU MUST HAVE SOFTWARE FOR BOTH THE PINBALL TEST UNIT AND THE GAME! This is because, when you compile the software code onto the Arduino, it erases any existing program from the Arduino. You can easily switch between two programs, but ONLY IF YOU HAVE THE SOFTWARE FOR BOTH! Make sure you have both sets of code before proceeding!

Purchase an Arduino: https://pinside.com/pinball/market/shops/1304-roygbev-pinball/by-game/185-flash-gordon

The Arduino can be purchased pre-programmed for a number of different pinball games. Before attempting to use your Arduino as a PTU, install it in your pinball as per the instructions that came with it, and ensure you can make it work as a game MPU. If it does not work as a game MPU, you cannot proceed!

Once you have the Arduino running your pinball game, you can proceed with converting it to a PTU. Once again, make sure you have the software code for both the PTU and the game!

Purchase the Arduino Integrated Development Environment (IDE): https://www.arduino.cc/en/software
(Free, but why not pay them a few bucks?)

Create a folder on your computer named Arduino. Within this you will create two folders; one named PinBallTestUnit, and the other named for the pinball game you own. The Arduino IDE expects the name of the game folder to be the same as the primary software file within the folder, which always has an extension of ino. For example, for a Flash Gordon you would name the folder FG2025p01, because the main program file for this game is named FG2025p01.ino.

Download the PTU software from https://github.com/DavesThinkTank/PinballTestUnit to the folder named PinBallTestUnit.

Download the game software to the game folder. You will need to find the software on the internet, or ask the supplier who sold you the Arduino for the code. Here is a fairly extensive list of games that have software available:

https://pinside.com/pinball/forum/topic/revisiting-the-classics-new-code-megathread

It is advisable to ensure that the Arduino IDE can compile the game code before proceeding. If it does not compile without errors, you do not want to upload it to the Arduino! The steps for compiling the game code, without uploading it to an Arduino, are covered below. If compiling the code produces error messages, you should not proceed.

If you have a laptop computer, it is fairly easy to plug the Arduino into your laptop without removing it from your pinball machine. The following instructions assume you will reprogram it this way. Otherwise, you will have to remove the Arduino, attach it to your desktop computer, then reinstall it in the pinball after completing the reprogramming steps.

With your pinball turned off, plug the Arduino into a USB port on your laptop using an appropriate cable. You need a cable with a USB micro connector on one end, and a USB A or C on the other end, whichever your computer needs. Make sure the “Switch” pins on the Arduino are connected with a jumper. Ignore the LED lights on your pinball’s circuit boards. It’s normal for the laptop to power on some of your pinball’s LEDs.

Open the file PinballTestUnit.ino (in the PinballTestUnit folder) with the IDE by double-clicking on it, or by running the IDE and selecting it using the File menu.

Click on the Verify checkmark (top left of the IDE screen) to verify that the software compiles properly. Any errors encountered will appear in red, in the black area at the bottom of the screen. There should be no errors in this step.

Click on the white box to the right of the checkmark. Click on "Select other board and port". Select "Arduino Mega or Mega 2560", and the port your Arduino board is plugged into.

Click on the Upload arrow (beside the checkmark) to compile the software and upload to the Arduino. Again, any errors will be displayed in red, in the black area at the bottom of the screen. You will need to deal with any errors before proceeding to the next step. If you have error messages, check that you have a jumper on the “Switch” pins. check your cable and connections. Check the board and port selections made above. Check if your computer’s firewall settings are interfering with the port.

Once the program has compiled and completed uploading, unplug the cable from your laptop. You can leave it connected to the Arduino if this is convenient.

When you turn on the pinball, the first thing you should see is the version number; 2001 in the player 1 display, and 01 in the credit window. This will last for about four seconds. If you don’t see this, you haven’t got the software running yet!

You can now proceed to the section below titled “Arduino Setup”, and run the tests on your pinball. Once you have tested one machine, you can remove the Arduino and install it in another machine to be tested.

After testing your pinball, you will want to reprogram the Arduino as a game MPU. First return the Arduino to the pinball it is to run. Then follow the compile and upload steps as above, but instead of compiling and uploading the file PinballTestUnit.ino, use the .ino file associated with your pinball game.

Arduino Setup

Before you can jump into the tests, the PTU needs to have some information about your pinball. There are nine steps you need to complete, but don't worry! They are all quick and easy.

Data Entry Step 1: Select Game

Ball in Play:	Step #01
Display #1:	Game number
Display #2:	01 if there is valid data at the current game number, 00 if invalid
Any Switch:	Increase game number
Any other Switch:	Decrease game number

The PTU can store information on up to 100 different machines, numbered 00 through 99. If you have previously entered data for a pinball, select the number you used to store its information. If you are entering a pinball's data for the first time, select any game number from 00 to 99. Display #2 lets you know if a game number has previously been used, but it can be re-used if you like.

The game number is shown in display #1, and can be increased by hitting any switch on the pinball. Continuing to hit this same switch, or holding it closed, will continue to increase the value. Releasing that switch and hitting any other switch will decrease the value.

Normally you would use the game/credit button on the front door of the pinball as the up button, and something convenient like a coin slot switch or slam switch for down. But you can use any switch in the pinball for either (except the flipper switches). This allows you to use any switches you prefer; in case some switches are not functioning!

If this step begins with display #2 indicating valid data in the current game number, hitting the red self-test button will take you directly to the first test, skipping the rest of the data entry steps.

If display #2 indicates invalid data, or if you switch up or down to a different game number, the red self-test button will take you to step 2, and you will need to complete all the remaining data entry steps.

If you want to re-enter the data for the current game, just change the number, and then change it back. Then hitting the red self-test button will take you to step 2, and you will be able to repeat all the data entry steps.

If the game number you select starts with valid data, that data will be used as the default values in the following data entry steps.

Data Entry Step 2: Set the Test Switches

Ball in Play:	Step #02
Display #1:	Primary switch number
Display #2:	Secondary switch number
Display #3:	"End tests" switch number
Any Switch:	Change display #1, 2, or 3 to any switch

The following steps, and the tests, need input from you. In this step you will designate two switches as your primary switch and secondary switch, to be used in providing this input. A third switch is also identified, which can be used to end the tests and return to "Select Game" (Step 1 above).

At first, the primary switch and secondary switch will be set to the up and down switches you chose in step 1, and the primary switch in display #1 will be flashing. To change this to any other switch, press that switch. Display #1 will now show your new selection, and display #2 will flash. Your secondary switch choice can then be changed, and display #3 will flash.

The usual choice for primary switch is the game/credit button on the front of every pinball. I have always added a free game button to all my machines, hidden discretely in the coin return slot and connected to the coin slot 3 switch, which is perfect as a secondary switch. You likely don't have this! The slam switch on the inside of the door is a good second choice. However, as indicated above, any switch in the pinball can be designated as primary, secondary, or end switch.

Press the red self-test button to proceed to the next step.

Data Entry Step 3: Number of Digits in each Display

Ball in Play:	Step #03
Display #1, 2, 3, 4:	Number of digits in player displays
Credit Display:	Number of digits in the credit / ball in play display
Primary Switch:	Increase number of digits
Secondary Switch:	Switch between player displays and credit / ball in play display

The PTU assumes your pinball has five displays; four player displays, and one credit / ball in play display. Although some pinball machines have a sixth display, the PTU cannot currently test this sixth display.

The PTU also assumes the four player displays are all the same, and have either 6 or 7 digits. When this step is entered, player #1 will be flashing, and all four player displays will indicate the assumed number of digits in each display. You can change this number with the primary switch.

The secondary switch moves the focus from the player displays to the credit display (and back again). When the credit display is flashing, the primary switch can be used to change the number of digits in the credit / ball in play display. This is usually 6 digits, but the PTU allows for machines that have a seven-digit display in this position.

Press the red self-test button to proceed to the next step.

Data Entry Step 4: Number of Switched Lights

Ball in Play:	Step #04
Display #1:	Number of switched lights
Primary Switch:	Increase number of lights
Secondary Switch:	Decrease number of lights

In this step you will tell the PTU how many switched lights are in your pinball. To be more accurate, you will tell it the highest number assigned by the pinball to any light.

This number primarily depends on whether your pinball has an auxiliary lamp driver board. If you do not have an aux lamp board, enter 59. If you do have this board, enter 87. You might be able to reduce this value slightly, as there are often unused values at the high end, but these values will usually be good enough.

Press or hold the primary switch to increase the number of lights. Press or hold the secondary switch to decrease the number.

Press the red self-test button to proceed to the next step.

Data Entry Step 5: Number of Solenoids

Ball in Play:	Step #05
Display #1:	Number of solenoids
Primary Switch:	Increase number of solenoids / relay number
Secondary Switch:	Decrease number of solenoids / relay number

In this step you will tell the PTU how many solenoids are in your pinball. And again, to be more accurate, you will actually tell it the highest number assigned by the pinball to any solenoid.

Solenoids seem to be assigned numbers in such a way that there are often a lot of unassigned values. If you are unsure what to put in this field, enter 14 if your pinball has 15 or fewer solenoids, or 29 if it has more. Later steps and tests will go through all the solenoids, and if there are a lot of unassigned values at the top, you can come back and assign a lower number.

Press or hold the primary switch to increase the number of solenoids. Press or hold the secondary switch to decrease the number.

Press the red self-test button to proceed to the next step. If you entered 15 or more above, surprise! You have one more value to enter. These pinballs can only control up to 15 solenoids, so if there are more, you need to identify a “Light” that controls a relay. This relay can be found under the playfield, and is used to switch between banks of solenoids. Enter the number of that light here. For example, my Bally Vector uses light #59 to control the relay. If you don’t know this value, enter anything for now. In the light test below, you can proceed through all the lights one at a time, and determine which one controls the relay. Then come back here and update this value.

NOW you can press the red self-test button to proceed to the next step!

Data Entry Step 6: Number of Switches

Ball in Play:	Step #06
Display #1:	Number of switches
Primary Switch:	Increase number of switches
Secondary Switch:	Decrease number of switches

In this step you will tell the PTU the highest switch number in your pinball. For most machines this number is 39, although some machines have extended the switch matrix with an additional row of eight.

Press or hold the primary switch to increase the number of switches. Press or hold the secondary switch to decrease the number.

Press the red self-test button to proceed to the next step.

Data Entry Step 7: Number of Sounds

Ball in Play:	Step #07
Display #1:	Number of sounds
Primary Switch:	Increase number of sounds
Secondary Switch:	Decrease number of sounds

In this step you will tell the PTU the highest number assigned to a sound by your pinball. If you are unsure, enter the maximum value of 255. You can come back later to change this value if necessary.

Press or hold the primary switch to increase the number of sounds. Press or hold the secondary switch to decrease the number.

Press the red self-test button to proceed to the next step.

Data Entry Step 8: Identify Sound Board

Ball in Play:	Step #08
Display #1:	Sound board number
Primary Switch:	Increase number
Secondary Switch:	Decrease number

In this step you will identify the sound board in your pinball. The available options are:

0: Squawk and Talk or Geeteoh
1: WAV Trigger

Press or hold the primary switch to increase the number. Press or hold the secondary switch to decrease it. Hopefully future releases will have more options!

Press the red self-test button to proceed to the next step.

Data Entry Step 9: Identify Solenoids to be Reset

Ball in Play:	Step #09
Display #1:	Solenoid number
Display #2:	01 if solenoid to be reset, 00 if solenoid not to be reset
Primary Switch:	Solenoid to be reset
Secondary Switch:	Solenoid not to be reset

Sometimes, when running a switch test, switches can get closed and cannot be easily reset. For example, if a drop target switch is activated by hitting the drop target, the only way to re-open the switch is to pry the drop target back up, or lift the playfield and manually activate the drop target's solenoid.

The PTU offers an alternative. Any solenoid identified here can be activated during the switch test by double-clicking the primary switch. This can be used to reset drop targets, or eject balls from hard-to-reach places.

This step will activate all the solenoids, one at a time. If you want to be able to activate the solenoid during switch tests, press the primary switch. If you do not want the solenoid to be activated, press the secondary switch. Your selection will briefly be shown in display #2 before moving on to the next solenoid. If you make no selection, the PTU will accept the value in display #2 and move on to the next solenoid after five seconds. You can identify up to six solenoids to be reset.

Note that, if you have specified a value higher than 14 in the solenoid data entry step above, the same solenoids will also fire for numbers 15 through 29, UNLESS you have specified the correct relay number in that same test. Even if you have specified the correct relay number, some solenoids will still fire both below and above 15. You can only specify six solenoids to be reset, so don't waste your options on firing the same solenoid twice!

Press the red self-test button to return to step 1. From there, press the self-test button again to go into the tests. You also have the option at that point to repeat the steps above, and re-enter the data.

Arduino Self-Tests

If you made it this far, congratulations! The following tests do everything that your pinball's original self-tests did, and so much more.

You can use the switch you designated as the "End Switch" in step 2 above to end the self-tests at any point (other than during the switch tests), and return to the "Select Game" step.

Test 1: Light Test

Ball in Play:	Test #01
Display #1:	Light number, or 99 for all lights
Primary Switch:	Cycle through switched Illumination lights. Hold to cycle continuously.

The first test will repeatedly flash all the switched illumination lights on the playfield and in the backbox. This is similar to the regular Bally light test, except the PTU allows you to now press the primary switch you set up earlier. When you do so, all the lights will stop flashing except one.

By continuously pressing the primary switch, the pinball will cycle through all the lights, displaying each, one at a time. Display #1 shows the corresponding light number. A table of all the lights and the value assigned to them can then be created.

Note that, in some pinball machines, one "light" is used as a switch to turn on a relay, which is then used to switch between two banks of solenoids. It is important to identify the number of this light, to be entered in the solenoid data entry step above. This can be done by simply proceeding through all the lights in this step, until you find the one which turns on the relay.

Test 2: Display Test

Display #1-5:	All digits cycle through numbers 0-9
Primary Switch:	Cycle through individual digits. Hold to cycle continuously.

Pressing the self-test button again will then take you to the display test. Again, this is similar to the Bally display test in that it cycles all digits in all five displays through the numbers from 0 to 9 repeatedly. It cycles quite a bit faster than the Bally test though, making this a much less tedious review!

And again, the PTU extends this test with use of the primary switch. When you press the primary switch, all displays will go blank except for the first digit on the first display, which will continue to cycle. Pressing it again moves this to the second digit. Pressing it again moves to the third, and so on, going through each digit of each display individually. After the final digit, pressing the primary switch will set all displays running through the numbers again. Holding the primary switch down will cycle quickly through each individual digit.

If there are problems with this test, try reviewing the number of digits per display entered earlier in the data entry steps. Incorrect values will have odd effects on this test.

Test 3: Solenoid Test

Ball in Play:	Test #03
Credit Display:	Switches firing due to solenoid activity (if any)
Display #1:	Solenoid number
Display #4:	Time in milliseconds between solenoid firing and switch activating
Primary Switch:	Fire current solenoid repeatedly. Press again to continue cycling.
Secondary Switch:	Stop solenoids from firing. Clear switch display (credit window).

Pressing the self-test button again takes you to the solenoid test. This runs through all the solenoids, just like the regular Bally test (except in a different order). Note, the Coin Door Lockout and the K1 Relay Flipper Enable are not included in these tests. Note also that the numbering of solenoids is different than you will find in your game manual.

New Features:

Pressing the primary switch at any point will cause the current solenoid to continue firing repeatedly, so you no longer have to cycle through all of the solenoids to see the one you are interested in. Press again to continue cycling. Press the secondary switch to turn firing of solenoids off, and back on. This allows you to both observe and work on a solenoid while remaining in test mode! Just remember to use caution, and keep hands and tools away from the electrical wiring!

Keep an eye on the credit window during this test. If vibration from a solenoid causes a switch to misfire, the switch number will be displayed here. The time between the solenoid firing and the switch activation is shown in display #4 (in milliseconds). If a solenoid is activating a switch, try cleaning and re-gapping that switch. Inspect the stiff metal blade between the two connecting blades to ensure it is situated properly, holding the blades apart and not shorting them. If the problem is persistent you may need to replace the switch. Press the secondary switch twice to clear the displays.

Note that, some solenoids are *supposed* to activate switches, and this is not an issue! For example, solenoids that pull down drop targets will activate the switch on that drop target.

The flippers are enabled throughout the solenoid test. This is therefore a good place to observe flipper issues.

Test 4: Stuck Switch Test

Ball in Play:	Test #04
Credit Display:	The number of switches currently closed
Display #1-4:	The lowest four stuck switch numbers
Primary Switch:	Double-click to reset all solenoids identified in step 9

Pressing the self-test again takes you to the switch test. Switches that are stuck on will be identified by number in the displays, like the original test. However, the PTU allows up to four stuck switches to be identified on four displays. The original Bally test displayed only the lowest-numbered stuck switch, making testing of multiple stuck switches and switch-matrix issues difficult. The number of closed switches is also displayed in the Credit display, for cases where more than four switches are closed at once. The switch numbers used by the PTU are the same as in your game manual.

In order to allow testing of the primary, secondary, and end switches, there are no special functions assigned to these buttons during the stuck switch test. The one exception to this is, double-clicking the primary switch will activate all solenoids identified in step 9 earlier. This allows you to easily test and work with drop target and other tricky switches, and then quickly and easily reset them.

Detecting Switch Matrix Issues with the Stuck Switch Test

The Stuck Switch test can also be used to locate switch matrix issues. The 40 (or more) switches of a pinball are wired together in an 8x5 grid. Diodes on each switch make sure one switch closing cannot affect any other switch, but a bad diode can cause problems. If a closed switch has a bad diode, and another switch in the same row is closed, and another in the same column is closed, then a fourth switch at the opposite intersection of the row and column will also register as closed.

Testing for switch matrix issues:

1. Fix all stuck switches. Make sure all switches are open. All four displays should be blank.
2. Test that all switches are working correctly. Make sure you know where they all are. Note that the switch matrix diagram in your schematics may be inaccurate. Note any errors.
3. Start with switch 0. Close the switch, and hold it closed.
4. Choose any other switch in the same row (refer to the switch matrix chart in your schematics). Close the switch, and hold it closed.
5. Choose any other switch in the same column. Close the switch, and hold it closed.
6. Three displays should show the three switches you are holding closed. If a fourth display indicates another switch, then switch zero has a bad diode and is causing a switch matrix error. (Note, the coin slot switches do not have diodes and *should* register as causing a switch matrix error.)
7. If there are two or more switches with the same number, be sure to test them all by opening the one you are holding, and closing the next one.
8. Open all the switches. Proceed to test switch 1, then 2, and every switch in sequence.

Test 5: Switch Bounce (Double-Hit) Test

Ball in Play:	Test #05
Display #1:	Most recent switch hit
Display #2:	The time between hits in milliseconds
Primary Switch:	Double-click to reset all solenoids identified in step 9

Pressing the self-test button again takes you to the switch bounce test. Switches on your pinball machine may develop a "bounce", where hitting them registers two or more hits. If you suspect this may be happening with a switch on your machine, this test can help you to identify the issue.

To determine whether a switch is bouncing, activate the suspected switch with a pinball. If it registers only once, the switch number will appear in the Player 1 display, and all other displays will be blank. If it registers two or more times, the time between hits will appear in the Player 2 display (measured in milliseconds). If a switch is bouncing, try cleaning and re-gapping that switch. If the problem is persistent you may need to replace the switch.

In order to allow testing of the primary, secondary, and end switches, there are no special functions assigned to these buttons during the switch bounce test. The one exception to this is, double-clicking the primary switch will activate all solenoids identified in step 9 earlier. This allows you to easily test and work with drop target and other tricky switches, and then quickly and easily reset them.

Test 6: Sound Test

Ball in Play:	Test #06
Display #1:	Sound Number
Primary Switch:	Play current sound repeatedly. Press again to continue cycling. Press within ½ second of display change to skip current sound. Hold to skip many sounds quickly.

Pressing self-test again takes you to the sound test. The original Bally test simply played a single sound. The PTU cycles through all the sounds. Pressing the primary switch plays the current sound repeatedly. Pressing it again will continue cycling sounds.

Display #1 will indicate the sound number to be played. If the primary switch is pressed within one half second of the display changing, the current sound will be skipped. Holding the button will increase speed, skipping sounds.

Be aware, each sound will take five seconds before proceeding to the next. This is a bit slow, but it generally prevents the sounds from running over each other. Also, some sounds have odd effects, such as disallowing other sounds to begin until they have finished. In some cases, background sounds may play continuously for the rest of the testing.

Testing and reviewing the sounds can be challenging. If a sound is making it difficult to test subsequent sounds, try the "skip" feature.

The sound test currently only works with Bally Squawk & Talk boards, or their equivalents, such as the Geeteoh replacement boards, or a WAV Trigger board. It also does not work with the very early S&T boards, or their Geeteoh replacements, on games like the 1979 Bally Star Trek. Later releases may be able to expand on this.

Test 7A: DIP Switch Test for 7-Digit Displays

The DIP switch test takes advantage of the fact that many pinballs have four 7-digit displays, plus four digits in the credit and ball-in-play displays, for a total of 32 digits. This allows the PTU to display the values of the pinball's 32 DIP switches. This also means that if the pinball uses 6-digit displays, there are only 4 x 6 + 4 = 28 digits to work with. If your pinball has only six-digit displays, go to the next section labeled "Test 7B".

Display #1 - 4:	DIP switch values (1 = ON, 0 = OFF), first seven digits of 4 DIP banks
Ball In Play Display:	DIP switch values for final digit of DIP banks 0 and 1 (switches 8 and 16)
Credit Display:	DIP switch values for final digit of DIP banks 2 and 3 (switches 24 and 32)
Primary Switch:	Move to next DIP switch. Hold to cycle through switches quickly.
Secondary Switch:	Change setting of current DIP switch

Pressing self-test again takes you to the DIP switch test. This completely new test shows you the setting of all 32 DIP switches, and allows you to change them temporarily. Turning the machine off and on again restores the DIP switches to the settings on the MPU board.

All 32 DIP switches are shown in the 32 display digits as either 1 (ON) or 0 (OFF). Since the displays are only seven digits, the first seven of each bank of eight are shown in the four displays. The eighth digit of each bank is shown in the Ball-In-Play or the Credit window. The current switch is identified by a flashing number.

By pressing the primary switch, you can scroll through switches 1 to 32. Stop on a switch and you can use the secondary switch to change its setting temporarily.

This can be useful to detect defective DIP switches, or just to review the DIP settings without having to open the backbox.

Press the red self-test button to return to step 1. From there, press the self-test button again to go back into the tests. You also have the option at that point to repeat the data entry steps and re-enter the game data.

Test 7B: DIP Switch Test for 6-Digit Displays

Display #1 - 4:	DIP switch values (1 = ON, 0 = OFF), first six digits of 4 DIP banks
Ball In Play Display:	Test #07
Credit Display:	DIP switch values for final 2 digits of current DIP bank
Primary Switch:	Move to next DIP switch. Hold to cycle through switches quickly.
Secondary Switch:	Change setting of current DIP switch

Pressing self-test again takes you to the DIP switch test. This completely new test shows you the setting of all 32 DIP switches, and allows you to change them temporarily. Turning the machine off and on again restores the DIP switches to the settings on the MPU board.

The first six DIP switches for DIP banks 1, 2, 3, and 4 are shown in displays 1, 2, 3, and 4, as either 1 (ON) or 0 (OFF). The last two DIP switches for the current DIP bank are shown in the two digits of the credit display. The current DIP switch of the current DIP bank will always flash. By pressing the primary switch, you can scroll through the 32 DIP switches, moving through all four banks, and the credit display will be updated with the final two digits of each DIP bank as it becomes the "current" DIP bank.

Stop on any switch and you can use the secondary switch to change its setting temporarily.

This can be useful to detect defective DIP switches, or just to review the DIP settings without having to open the backbox.

Press the red self-test button to return to step 1. From there, press the self-test button again to go back into the tests. You also have the option at that point to repeat the data entry steps and re-enter the game data.

Self-Test Information Tables

The following tables can be used, together with the self-test features, to investigate the functioning of your pinball. These tables will assist you in understanding the game feature being indicated by the values displayed during the tests.

The tables of lights, solenoids, switches, and sounds are for one particular game, a 1981 Bally Flash Gordon. They are included to help you picture what is happening in the tests. Similar tables can be created for all of your pinballs using the results of the PTU tests.

List of PTU Data Entry Steps and Tests

Ball in Play Display – Step #	Credit Display – Test #	Setting or Test
1		Select Game
2		Set the Test Switches
3		Number of Digits in each Display
4		Number of Switched Lights
5		Number of Solenoids / Relay Number
6		Number of Switches
7		Number of Sounds
8		Identify Sound Board
9		Identify Solenoids to be Reset
	1	Light Test
	2	Display Test
	3	Solenoid Test
	4	Stuck Switch Test
	5	Switch Bounce (Double-Hit) Test
	6	Sound Test
	7	DIP Switch Test

Lights (1981 Bally Flash Gordon)

No.	Light	No.	Light
0	Mini 1	44	10,000
1	Mini 2	45	20,000
2	Mini 3	46	Extra Ball (Up/Down Kicker)
3	Mini 4	47	5X (Drop Targets)
4	Mini 5	48	Backbox Ball in Play
5	Mini 6	49	Backbox High Score to Date
6	Mini 7	50	Backbox Game Over
7	Mini 8	51	Backbox Tilt
8	Mini 9	52	Top Pop Bumper
9	Mini 10	53	Extra Ball (Wood Beast Ramp)
10	Right Spinner Arrow	54	30,000
11	Left Spinner Arrow	55	Collect Bonus (Upper Level)
12	Super 1	56	Right Outlane Special
13	Super 2	57	Left Outlane Special
14	Super 3	58	Rollover 1
15	Super 4	59	Special (Upper Level)
16	Super 5	60	Rollover 2
17	Super 6	61	Rollover 3
18	Super 7	62	Rollover 4
19	Super 8	63	Rollover 5
20	Super 9	64	Backglass Flash 1
21	Super 10	65	Backglass Flash 2
22	Mini Bonus	66	Backglass Flash 3
23	Super Bonus	67	* not used
24	2X	68	Backglass Gordon 1
25	3X	69	Backglass Gordon 2
26	4X (Lower Level)	70	Backglass Gordon 3
27	5X	71	* not used
28	1 Arrow	72	Observers Plastic (Lower)
29	2 Arrow	73	Observers Plastic (Upper)
30	3 Arrow	74	* not used
31	4X (Upper Level)	75	Backbox Strobe
32	Target Amber	76	3X 15 Second Clock
33	Target Yellow	77	2X 15 Second Clock
34	Target Blue	78	3X Arrow
35	Target White	79	2X Arrow
36	Right Target (Lower)	80	* not used
37	Right Inner Lane	81	* not used
38	Left Inner Lane	82	* not used
39	Right Target (Upper)	83	* not used
40	Backbox Shoot Again	84	* not used
41	Backbox Match	85	* not used
42	Shoot Again	86	* not used
43	Apron Credit Indicator	87	* not used

Solenoids (1981 Bally Flash Gordon)

No.	Solenoid
0	4 Drop Targets Reset (Lower Level)
1	3 Drop Targets Reset (Upper Level)
2	Inline Drop Targets Reset
3	Up / Down Kicker: Kick Down
4	* not used
5	Knocker
6	Outhole Kicker
7	Up / Down Kicker: Kick Up
8	Single Target Reset (Up)
9	Left Pop Bumper
10	Right Pop Bumper
11	Single Drop Target Down
12	Top Pop Bumper
13	Left Sling Shot
14	Right Sling Shot
15	Coin Lockout Door (not included in tests)
16	K1 Relay Flipper Enable (not included in tests)

Switches (1981 Bally Flash Gordon)

No.	Switch
0	2 Left and Right Rollover Buttons
1	3 Shooter Lane Rollover Buttons
2	Top Single Drop Target
3	Shooter Lane Rollover Switch
4	Drop Targets 50 Point Rebound (2)
5	Credit Button
6	Tilt
7	Outhole
8	Coin 3 (Right)
9	Coin 1 (Left)
10	Coin 2 (Center)
11	Bottom Right-Side Target
12	Flipper Feed Lane (Right)
13	Flipper Feed Lane (Left)
14	Top Right-Side Target
15	Slam (3)
16	4 Drop Target “A” (Bottom)
17	4 Drop Target “B”
18	4 Drop Target “C”
19	4 Drop Target “D” (Top)
20	3 Drop Target “A” (Top)
21	3 Drop Target “B”
22	3 Drop Target “C” (Bottom)
23	Top Target
24	1st Inline Drop Target
25	2nd Inline Drop Target
26	3rd Inline Drop Target
27	Inline Wood Beast Target
28	10 Point Rebound (2)
29	Up / Down Kicker
30	Right Outlane
31	Left Outlane
32	Right Spinner
33	Left Spinner
34	Right Slingshot
35	Left Slingshot
36	Top Pop Bumper
37	* not used
38	Right Pop Bumper
39	Left Pop Bumper

Switch Matrix (1981 Bally Flash Gordon)

0: Two Left and Right Rollover Buttons (4)	8: Coin 3 (No Diode!)	16: 4 Drop Target "A" (Bottom)	24: 1st Inline Drop Target	32: Right Spinner
1: Three Shooter Lane Rollover Buttons (3)	9: Coin 1 (No Diode!)	17: 4 Drop Target "B" (Lower Mid)	25: 2nd Inline Drop Target	33: Left Spinner
2: Single Drop Target	10: Coin 2 (No Diode!)	18: 4 Drop Target "C" (Upper Mid)	26: 3rd Inline Drop Target	34: Right Slingshot
3: Shooter Lane Rollover (1)	11: Right Side Lower Target	19: 4 Drop Target "D" (Top)	27: Inline Back Target	35: Left Slingshot
4: Drop Targets, 50 Point Rebound (2)	12: Flipper Feed Lane (Right)	20: 3 Drop Target (Top)	28: 10 Point Rebound	36: Top Thumper Bumper
5: Credit/Game Button	13: Flipper Feed Lane (Left)	21: 3 Drop Target (Middle)	29: Saucer	37: Not Used
6: Tilt	14: Right Side Upper Target	22: 3 Drop Target (Bottom)	30: Right Outlane	38: Right Thumper Bumper
7: Outhole	15: Slam (3)	23: Top Target	31: Left Outlane	39: Left Thumper Bumper

Notes:

1. The coin 1, 2, and 3 switches do not have diodes. This means, if used during a game, they could cause a switch matrix issue. They are also handy for testing and understanding switch matrix issues for this reason.
2. There is no switch 37. However, it can be "switched on" through a switch matrix issue!
3. The columns are labeled ST 0 through ST 4 (ST for strobe), and are wired to the MPU board through connector pins A4J2-1 through 5.
4. The rows are labeled I 0 through I 7 (I for input), and are wired to the MPU board through connector pins A4J2-8 through 15.

Sounds for Squawk and Talk (1981 Bally Flash Gordon)

No.	Sound	No.	Sound
0		26	Crash bounce down
1		27	Crash bounce up
2		28	Outlanes
3		29	Crash
4	Humm (low)	30	Background sound 6
5	Sound off	31	Background sound 7
6	Background sound 1	32	Ding 1
7	Rebound hit	33	Ding 2
8	Spinner humm medium	34	Ding 3
9	Spinner humm low	35	Ding 4
10	Timer sound	36	Background sound 8
11	Background sound 2	37	Background sound 9
12	Boink up high	38	Background sound 10
13	Boink up low	39	Background sound 11
14	Background sound 3	40	"Ignite death ray, 15 seconds"
15	Background sound 4	41	Ming laugh five times
16	Alarm	42	"Lucky shot Earthling"
17	Low grumble	43	"Miserable Earthling"
18	Up / down kicker	44	"Emperor Ming awaits"
19	Background sound 5	45	"Flash"
20	Drop target hit	46	"Try again Earthling"
21	Beep beep hit	47	"15 seconds"
22	Up / down kicker	48	"Miserable Earthling"
23	Up / down kicker	49	"Flash"
24	Bong bounce down	50	Ming laugh (single)
25	Bong bounce up	51	"15 seconds"

Sounds, Geeteoh Board (1981 Bally Flash Gordon)

Arduino	Gee-teoh	Sound	Ard-uino	Gee-teoh	Sound
0	255		26	229	Zap (Electric)
1	254		27	228	Look out Flash!
2	253		28	227	What a Damn Nuisance!
3	252		29	226	Zap Sound, Down
4	251	This way Flash, come on!	30	225	Match sound
5	250	Not used by Geeteoh	31	224	Your power's fading, Ming
6	249	Flash by Queen, instrumental	32	223	Tone
7	248	Blaster	33	222	Tone+
8	247	Ray Gun	34	221	Tone++

Arduino	Gee-teoh	Sound	Ard-uino	Gee-teoh	Sound
9	246	Low hum	35	220	Tone+++
10	245	15 second alarm	36	219	Oh Dear, How Pathetic
11	244		37	218	You've saved your Earth. Have a nice day. Yeah!
12	243	Ascending, low	38	217	Kid Ming laugh
13	242	Ascending, high	39	216	Kids cheering
14	241		40	215	Open fire, all weapons!
15	240		41	214	Gently Darling, it's extremely sensitive… like me!
16	239	Old Alarm	42	213	Very roughly, 14 seconds!
17	238	Switches over there, start hitting them!	43	212	The attack has begun!
18	237		44	211	Gordon's alive!
19	236		45	210	Flash!
20	235	Ming's Ring	46	209	You've saved your Earth. Have a nice day. Yeah!
21	234	Ray Gun	47	208	Gordon's alive!
22	233	Escape is impossible!	48	207	Oh dear…
23	232		49	206	Flash!
24	231	Bounce (Low)	50	205	Ming laugh!
25	230	Bounce (High)			

73	182	Oh, dear…	84	171	Background music for Skill Shot
74	181	Wood Beast roar!	85	170	Try the Wood Beast, or die!
75	180	Oh, Flash	86	169	Remove the Earth Woman. Forget it Ming, Dale's with me!
76	179	How? By magic, of course.	87	168	This place is a lunatic asylum!
77	178	Don't kill him yet, father.	88	167	Football alarm, end
78	177	15-second hurry-up timer	90	165	Stop all sounds
79	176	5-second hurry-up timer	94	161	Oh, well. Who wants to live forever?
83	172	Background music for Final Battle	95	160	Oh, dear. How pathetic.
			254	1	This way Flash, come on!