

Pinball 2000 Repair

From PinWiki



Note: This page is a work in progress. Please help get it to a completed state by adding any useful information to it.

Click to go back to the Williams solid state repair guides index (http://pinwiki.com/wiki/index.php?title=Williams_Repair_Guides) .

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1 Introduction

Pinball 2000 (P2K) was the answer to a failing pinball industry. This was the last system used in a pinball machine before Williams ceased production of pinball machines. The reasons for why Williams ceased production is highly debated and more information can be found [here](#).

This system was a hybrid of conventional pinball with a video aspect. Using a 19" arcade monitor and special playfield glass that is coated to reflect the image, it created the illusion of holographic images on the playfield. This is known as the Pepper's Ghost effect. (http://en.wikipedia.org/wiki/Pepper%27s_ghost) To be able to handle both the pinball and video aspects of the game, the designers of Pinball 2000 used a commercial off the shelf PC based on a unique graphics and CPU processor, the Cyrix MediaGX. There are two proprietary components, the PRISM card, which contains the roms and booted the PC without a hard disk, and an audio amp. Unfortunately, the software requires the Cyrix MediaGX CPU for its display. The MediaGX did not sell well, and the boards and chips are now hard to find.

Only two games were released using the P2K platform, with 2 or 3 in development when Williams ceased production.

2 Games

- Revenge From Mars
- Star Wars Episode 1
- Wizard Blocks *
- Playboy *

** Denotes a game that was never produced*

3 Technical Info

Pinball 2000 was run using a commercial PC with the Cyrix Media GX CPU. The software depends on the integrated graphics in the Media GX CPU to operate. The PRISM card is a PCI card that carried the masked ROMs (64MB, the most dense possible in a 16-bit configuration), and ran the basic boot process of the PC to run Pinball 2000. Along with the PRISM card, the PC contained a custom audio amp to drive the stereo speakers and subwoofer.



Pinball 2000 Driver Board



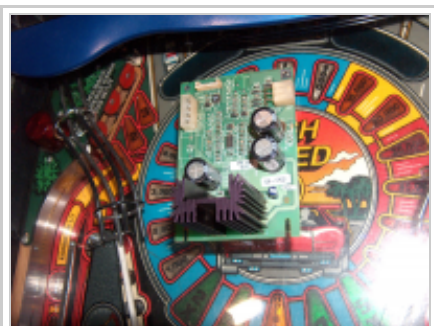
Pinball 2000 ROM Card



Pinball 2000 Prism Card



Placeholder for Pinball 2000
power supply



Pinball 2000 Audio Amplifier
Board

Optional pieces of hardware available for the Pinball 2000 system would be the SMC8416T ethernet card and a barcode reader. These worked to be able to access bookkeeping info over the internet and also host tournaments involving barcode based "login" to the system.

Three types of the SMC8416 will work: SMC8416T , SMC8416BT and SMC8416BTA. The last letters refer to the type of Ethernet interface installed. 'T' refers to RJ-45 which is the current type of 'wired ethernet' and is available on all three cards.

Currently working on this, including adding pictures

Note that there was a complete drop-in replacement solution if your P2K needs repairs beyond what is covered here. See NuCore (<http://www.bigguyspinball.com/nucore.shtml%7C>) for information. NuCore has since suspended sales of their product with no public plans to restart.

More than one Cyrix Media GX Motherboard was used, so you need to find a manual with a layout that matches your game.

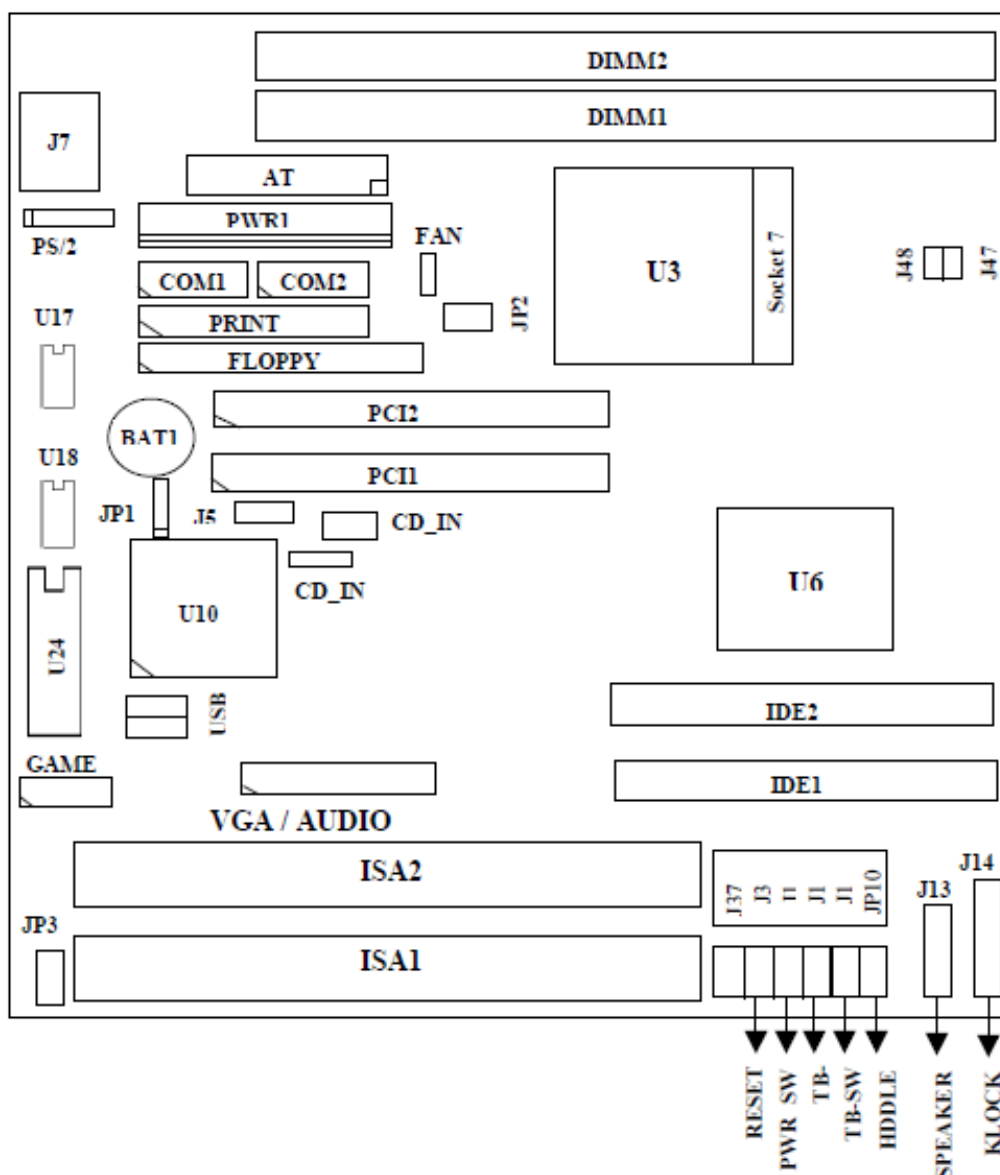
Here are links to Cyrix 586-GXM-AV (<http://www.blacknightpinball.com/rfm/Cyrix-Motherboard-gxm-av.pdf>) and the InformTech 586-GXM+ (<http://www.blacknightpinball.com/rfm/Motherboard-it-596-gxm.pdf>)

EXAMPLE MOTHERBOARD SPECIFICATIONS	
586 GXM-AV	
Manufacturer	AVT INDUSTRIAL, LTD
Device Type	Motherboard
Processor	Cyrix GX (Socket 7)
Processor Speed	166/180/200/233MHz
Chip Set	Cyrix
Maximum Onboard Memory	128MB SDRAM DIMM Slots (2) PC100 168-pin DIMM will work
Cache	None
BIOS	Award
Dimensions	220mm x 170mm
I/O Options	32-bit PCI slots (2), floppy drive interface, game interface, green PC connector, IDE interfaces (2), parallel port, PS/2 mouse interface, serial ports (2), VGA interface, USB connector, audio in- CD-ROMs (2).
NPU Options	None (no optional Numeric Processor)

586 GXM-AV Motherboard Connections			
Interface Purpose	Location	Interface Purpose	Location
Floppy drive interface	CN1	Serial port 1 (COM1)	P1
IDE interface 2	CN2	Serial port 2 (COM2)	P2
IDE interface 1	CN3	Parallel port (LPT)	P3
Reset switch	J1	Game interface	P4
Power LED & keylock	J2	PS/2 mouse interface	P5
IDE interface LED	J3	VGA interface	P6
Chassis fan power	J4	USB connector	P7
CPU fan power	J5	VGA interface	P8
Green PC connector	J6	Audio connector	P10
Audio in – CD-ROM	J7	Baby-AT Power connector	P11
32-bit PCI slots	PC1 – PC2		
Note: Refer to your board manual for physical locations.			

InformTech 586-GXM+ Motherboard Jumpers			
Jumper Purpose	Location	Jumper Purpose	Location
Normal CMOS Operation	JP3:1-2	Clear CMOS	JP3:2-3
180MHz CPU Clock	JP47:out JP48:in JP2:1-2	200MHz CPU Clock	JP47:in JP48:out JP2:1-2
233MHz CPU Clock	JP47:in JP48:out JP2:3-4	266MHz CPU Clock	JP47:in JP48:out JP2:none
300MHz CPU Clock	JP47:in JP48:out JP2:3-4 & 5-6	JP2 Orientation	Pin 1 Bottom Left with board as below
Note: The use of JP47/48 with JP2 are for CPU clocking. Refer to your manual for details.			

InformTech 586-GXM+ Motherboard Layout (your actual board layout may differ)



4 Problems and Solutions

4.1 Entering and Viewing Bookkeeping and Diagnostics

++++Discuss how to enter bk and diags via the door, and how to view the "reversed" monitor.+++

Bookkeeping and diagnostics can be handled in 2 different ways. The more traditional method is to use the 4 coin door buttons, the other method is through the use of a keyboard.

4.1.1 Traditional Coin Door Method



The four buttons inside the coin door

The first step to this is obviously opening the coin door. Once opened, you will see 4 buttons. From left to right they are: "escape", "minus", "plus", and "enter". The basic function of the buttons are relatively simple.

Enter will let you enter a menu or option that you want to change, escape allows you to go back, and the plus and minus are used for navigation, as well as changing any adjustments you

select.



Service Buttons Front



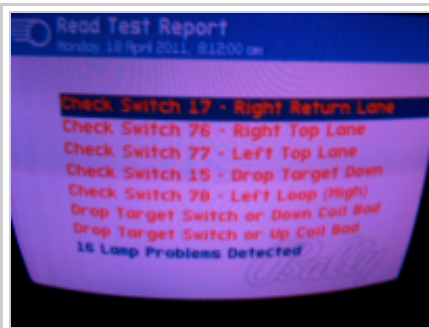
Service Buttons Top

To enter the menu, start by pressing the enter button. This will bring you to the screen shown to the side. From here you have many different things you can do. Tasks include viewing the test report, diagnostics, bookkeeping, utilities, printouts, and language.

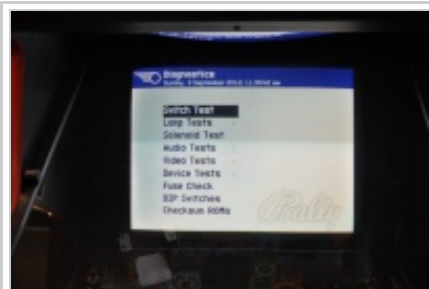


Main operator menu

The test report offers a good general summary of items that commonly decrease earnings on location, or other major system errors. Things like burnt out lamps, switch errors, disabled features, and hardware failures. This area can be seen in the picture on the side.



A sample test report



Diagnostics menu

The diagnostics menu will allow you to run switch tests, lamp tests, solenoid tests, audio tests, video tests, device tests, fuse checks, dip switch viewing, and checksum the roms. The switch test will allow you to view switches that are currently active, as well as map the location of each switch on the playfield. Lamp test will allow you to trigger lamps, one at a time, each row or column, all at once, or the flashers. This is a great tool to see which lamps are working as the onscreen menu will tell you which ones are having issues (shorted or burnt out) as well as telling you where the bulb is with the onscreen map. The solenoid test menu will cycle through all the

solenoids and flashers in the cabinet. If you press the enter button you can select repeat, and press it again to stop. Using the plus and minus buttons will let you select which coil to fire. Audio tests will allow you to drive a test tone to each of the 3 channels in the pinball machine as well as testing the "knocker" sound. Video tests provide screens for displaying different patterns that are useful for adjusting the monitor.

4.1.2 Keyboard Method

4.2 Power Problems



Pinball 2000 PC inside the head

The AT power supply in the PC case is a common failure. If your power supply fails, you have two options:

- 1. Find another Baby-AT power supply, or
- 2. Put an ATX power supply into your machine. The first option is becoming extremely hard because of how old the AT power supplies are, so you may not be able to find one. Option 2 involves grounding the green wire in the molex connector of an ATX PSU to any of the next door black wires to force the motherboard to boot. You can cut the wires from the molex and tape them together, or just make a wire jumper link. The ATX supply will boot when the AC power is supplied and a load exists, which is what we want.

*** Warning! *** The PC inside a Pinball 2000 game *always runs at 120v AC* as it gets it's power from the transformer in the pinball cabinet. So if you are in a country that uses 240v DO NOT plug in the PSU directly to the mains socket with a PC mains lead. If you need to run the computer out of the game to do diagnostics on the motherboard, check that the switch on the back of the PSU is at 240v before plugging in into the mains! Also remember to set *any PSU back to 120v* before installing it in the game and powering up the pinball machine.

I learned this lesson the hard way... and had to replace my AT PSU. It won't happen to those of you who live in the USA.

4.3 General PC issues



Inside Pinball 2000 PC

One of the issues with the PC is that the fan on the CPU heatsink is prone to failure. Once the fan stops working, the CPU overheats and over time will eventually fail. A big factor that causes the fan to fail is the foam piece that goes across the lid. Due to heat, the glue gives up and it sags right down on top of the fan. The best thing to do is



Trim foam to look like this

to trim it back to just over the PRISM card, which is the foam's original purpose.

Another tip for prolonging your PC's life is to underclock the CPU., which will be detailed here once I pull up my info for it.

4.4 CMOS and Prism card batteries



Pinball 2000 PRISM Card

There are a couple coin style batteries used on the P2K computer. One on the motherboard and another between the prism cards. The motherboard battery is a standard CR2032, and the one in between the prism cards is a BR2325 coin style batteries. It would be a good idea to replace these if they have not been already. The prism card battery is



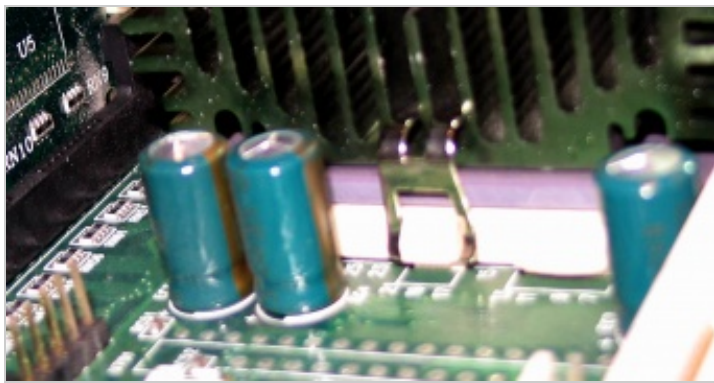
Pinball 2000 ROM Card

sort of an odd size and good luck finding it at your local Radio Shack. If so be prepared to pay much more. These can be ordered online for a LOT less delivered.

4.5 Motherboard Issues

Symptom: Won't Boot

Leading Cause: Bad Motherboard Capacitors



Pinball 2000 Bulging Caps

Pinball 2000 machines use computer motherboards that have capacitors very prone to leakage that tend to puff up and then leak out. Once they puff up, it can

cause erratic operation. Once the tops break, even a little, and they begin to leak, it will cause the machine not to boot. Fortunately, they can be replaced.

There are at least two kinds of caps in the Pinball 2000 motherboards in the 5 spots numbered in the picture. One has green caps (bad), and the other light blue (good). The green caps are 6.3v, 1000uf, 105c and made by TAYEH. These are the ones that you will usually find as bulged, popped, or leaking. If you see light blue 10v 1000uf, 105c caps from Xicon, you're probably all right. I haven't seen any of these bulged or leaking and your problem probably lies elsewhere.

If your Pin2k computer box will not boot when hooked to an external monitor with the prism card removed, look at the 5 numbered locations in the picture. They are all the same capacitor. If ANY are bulged or leaking replace ALL FIVE. Mouser carries suitable replacement caps. Check for part number 647-UHE0J102MPD. Or, if you want to use a 10v cap like the blue ones, go for it. Just make sure they're 1000uf, and the same form factor.

When removing the existing caps and replacing them with the newer ones, be VERY CAREFUL. There are a ton of fine traces near the pads for these caps, and this is a multi-layer board. Take it slow and use a bit of new solder to loosen up the existing solder if necessary. Just stay patient, and do NOT overheat the solder pads. Remember, just one "oops" will make this basic repair much more painful or even impossible.

Once you get the caps out, note that the caps are marked with a "--" and a stripe on the negative side. Just make sure you put the positive back on the positive side and the negative on the negative (the board is marked with a "+" where the positive lead goes).

Once all 5 are replaced, put the machine back together and power it up. If you had the Tayeh caps, chances are you've just rescued the motherboard in your pin2k machine for about an hour labor and \$1.00 in parts.



Pinball 2000 Bad Cap Locations

4.6 Solenoid problems

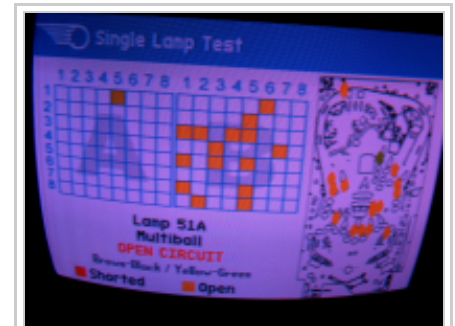
Be sure connectors are on coil lugs tight. Vibration can loosen them and burn the lugs. The female spade connectors were used to allow for quick and easy replacement of solenoids. If a lug connection is loose or sloppy, it is best to just solder the wires directly to the coil lug.

If a connector slips off the flipper coils, it could potentially short to an adjacent flipper coil lug, and take out the drive transistor for the flipper coil. The short can occur, because the connections are unfortunately not insulated.

Connections between the playfield and cabinet's interconnect can also be problematic. This can be caused by the playfield wiring harness stressing the connections. If solenoids are not engaging, check these connections.

4.7 Lamp problems

With Pinball 2000 came some methods to help make operator maintenance easier. One of those features is a burnt out lamp detection. The only problem with this is that if you put LEDs in your machine, they draw too little current to be detected as good and will report as bad to your machine. LED bulbs will also strobe incorrectly for the feature lights after the machine is on for some time. Generally speaking, LED lighting is a bad fit for Pin2k machines, other than possibly the General Illumination.



Lamp Test Menu

4.8 Switch problems

The switches are a common failure on these machines. The sub-microswitches used throughout the playfield are susceptible to sporadic or total failure, like some WPC-95 games. Most switch related problems are the switch itself not the switch matrix. Replacement of the switches is the only resolution to make them reliable again. These are common switches in a Pinball 2000 machine:

- 5647-12693-19 (<http://www.pinballlife.com/index.php?p=product&id=829&parent=0>) (rollover lane micro switch)
- Williams/Bally DA3 Switch Body (<http://www.pinballlife.com/index.php?p=product&id=1863&parent=101>)

(DB3 is the modern equivalent - but not as good. Buy the DA3 switch body (if still available) and snap on the original actuating wire.

Problem: Machine reports coin door open all the time

Solution: Check motherboard mount in Pin 2000 computer case

If your machine is reporting this, check the raised mounts under the motherboard in the Pin2k computer case.

Inside the Williams Pinball 2000 computer case, there are 6 raised, threaded metal lugs acting as mounts beneath the motherboard to secure it to the case. However, some of the replacement boards don't allow all the holes to line up. The top middle peg (closest to the power supply) can grounding out on the bottom of the motherboard where there was no hole to secure it and causing the machine to think the coin door was open.

To fix this, cut three rubber mini post grommets in half horizontally to make two small rubber doughnuts and use the six rubber pieces to create insulators for all six posts. Once it's insulated and re-secured to the mounts through the insulator/spacers you made, problem should be solved!

4.9 Monitor problems



Bad idea if charged

The monitor inside a Pinball 2000 machine is a normal low-resolution arcade monitor. Two different brand CGA monitors were put in Pinball 2000 machines, a Wells-Gardener 19K7302 or a Ducksan CGM-1901CW. At this age, most of these monitors could use adjusting, if not a capacitor kit. Working on the monitor or chassis is not much different than working on a video arcade game monitor & chassis. Re-capping the chassis, neck board and re-flowing major solder joints is a good start to bullet proof your machine. If you are removing the high voltage connection to the CRT tube **DISCHARGE IT** a couple times before grabbing it. You can do it with a long screw driver with the shank grounded. Slide it under the rubber insulating cup, and when contact is made, a pop or snap will be heard. Do

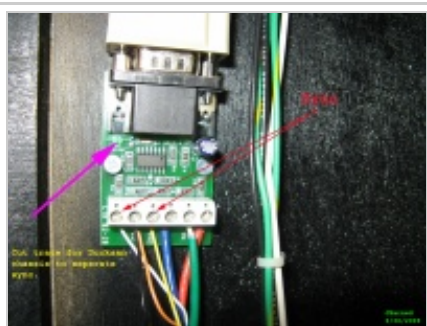
this a couple times before touching it. The tube can sometimes have a residue charge, even if it hasn't been turned on in awhile. Always discharge it before touching it. One note on the Ducksan chassis. There is a fuse on the chassis that if blown, it will not discharge a couple big capacitors on the board. If for some reason this fuse is open or blown the capacitors will have a charge until you ground them or touch it. Look for a blown fuse on the chassis before prodding a lot of things.

If you see a blown fuse, discharge the big caps on the chassis. **On the upside if you do discharge it with your body you will remember it longer than reading about it!**

Another option for Pinball 2000 monitors include purchasing an LCD and mounting it place of the CRT. This option will require a signal converter to convert the low resolution signal to something a VGA computer monitor can handle.

4.9.1 Monitor Adjustment

4.10 Video Amplifier



Video Amp

Adding a video amplifier to the standard CRT monitor drastically increases contrast and color. This is a fairly simple and relatively cheap add-on. The recommended video amp can be purchased from Ultimarc



Amp mounted in a Revenge from Mars

(<http://www.ultimarc.com/vidamp.html>) . Installation is basically feeding the serial cable output from the P2000 computer into the video amp. Wires will have to be attached to the amp's screw down terminals. These are the RGB (Red,Green,Blue) and Sync. wires. These run from the amp output (screw down terminals) to the CRT chassis.

With Wells Gardner, the sync wires can be joined together. Here is a link to the pin outs (http://www.Scirocco2.de/rfm_monitor_plug.jpg) on a Wells Gardner. You would use the first four pins: R,G,B

and Gnd . And the last three: Gnd, V/Sync, H/Sync. The two ground wires tie together. Locations are clearly indicated on the video amp.

On Ducksan chassis, the Sync wires will be separated. If using the Ducksan chassis, there is a small board trace on the amp that must be cut. This is so the video sync is correct. If the sync is wrong, the symptom will be a rolling picture that can not be adjusted. If hooked up incorrectly, there shouldn't be any ill results, except there will not be a picture.

An important point is that your game's PC video card may not output +5v on pin 9, which is needed to run the Ultimarc video amp board. Test this with a meter set to DC volts between pin 9 and the metal shell of the cable supplied with the video amp connected to your PC and with the game up and running attract mode. From experience, Star Wars Episode I won't output the +5v, but the later RFM boards probably will. If you have no +5v, the upgrade will appear to fail and you get no video. Fear not. You need to run a long connection from a spare 4-pin molex drive connector (connect to one of the Red wires) in the PC out to the Video amp. The isolated pad it needs to be soldered to is indicated at the bottom of the ultimarc product page and shown here (<http://www.ultimarc.com/images/vidampconn.jpg>) . Then cable tie the wire to the whole length of the supplied video cable leaving some slack at the ends. You don't need to run a separate ground wire, the shield of the cables and other earthing takes care of it for you.

If you have a very slight wobble side-to-side in the picture, try isolating the video cable run away from the black/green/white wires that carry the AC power. Beyond that consider re-capping the chassis, neck board and re-flowing (solder) connections. This is highly recommended. Once the amp is installed and running, it's a good idea to turn the contrast down on your chassis or neck board adjustment pot. The amp will really kick it up a lot from its previous setting. It's not a bad idea to adjust the focus on the flyback too. With the amp installed, it's a night & day difference for image quality, color and contrast.

If the existing CRT tube is good, video amp is a nice add on. I am not a huge LCD display advocate for games that originally used CRT tube monitors. The black level of CRT tubes is difficult to replicate with LCD / LED panels. However, that is not to say modern LCD panels don't look good. Since the CRT display is going the way of the 8 track player, I want to keep mine running as long as I can!

4.11 Sound problems

The audio amp circuit board inside the PC box is pretty reliable, but if it does ever have problems, there are 2 strikes against it:

1. It is a proprietary board from Williams.
2. The majority of its components, less the amp and some electrolytic capacitors, are surface mount components.

This makes service and replacement a little bit of a challenge.

The other side of the audio is based on the PRISM card which is also all surface mount and out of date chips that are challenging to find.

The Nucore folks at Bigguys Pinball have created a modern replacement amplifier board for Pinball 2000. It is available from Pinball Life (<http://www.pinballlife.com/index.php?p=product&id=1550&parent=231>) for \$119 and should work as a replacement if you can't fix the one for your game.

4.12 Flipper problems

It should be noted that the E.O.S. switches are normally open.

5 Modifications

5.1 Adding Saucer Lights to RFM

The first option is to buy and fit a kit:

The one from UFO Pinball (<http://www.ufopinball.com/RFM-LED/features.htm>) costs \$140 plus shipping. It's a nicely designed mod at a decent price. I have the UFO Pinball mini-saucer kit (by Bill Ung) on my AFM, which is highly recommended by all who have it. The saucer animation on the RFM kit appears to be done in a similar way, although the RFM mod is provided as a PCI card that fits neatly inside the Pinball 2000 PC.

The second option is to make your own saucer mod:

I've built a simple "knight rider" style LED scanner (<http://www.pinballnews.com/learn/rfm.html>) which I saw in Pinball News (along with the Martian LED "eye mod"), and played with that on the mini-saucers. It gave a basic idea of adding LEDs to the game, but was limited to a single pattern that just "spins" the LEDs around or scans them back and forth. You would have to add a switch somewhere to select when the scanning was "on".

I then built a more complicated PIC based board with lots of amazing scan patterns and with LED intensity variations. The plan was to connect it to the lamp matrix flashers using an optocoupler, but I wasn't very happy with either of those for RFM mini-saucers. The first type of scanner was simple and didn't fit in with the gameplay, the PIC board is overly complicated but can be programmed for lots of different patterns. There's an easier way to get there.

If you can fix simple faults on pinball games then there is a mod you can do with these features:

- Saucer LEDs are (automatically) interactive with the game.
- Saucer LEDs are off during lots of the modes where it would distract the player. Off during Flasher shows.
- Patterns are quite cool. Some modes scan, some spin around CW and CCW, and others will sparkle/flash (such as at end of modes).
- Shows a count of the saucer lights scored. As you score more lights, more LEDs on the saucer spin giving varied patterns.
- You can add an optional saucer body with the sequenced lights to the flasher above the SOL hole. Mine has a red flasher dome with red LEDs.
- Cost is low, although as with most pinball mods some work is required.

It takes a few parts and some patience. You need to be able to terminate crimp connections and do basic soldering - that's it. You will need to learn those skills for pinball repair anyway, so this mod is worth a shot. I designed it so you (or the next owner) can remove the mod completely, but personally I think it works well with the game and you won't want to.

It's based on an idea from Levi, a great guy from the Pinball group in Brazil. I emailed and discussed the mod with him some time ago: Original Levi mod in action. (<http://www.youtube.com/watch?v=QCdQ1xWz0ag>)

As you can see, it involves wiring the LEDs into the mothership saucer lights on the playfield which already scan under game control. I've had mine connected up for around two years with no problems running 3 mini-saucers. I don't think the LEDs add much of a load to the Lamp Matrix. The diagnostics won't give you lamp errors, because the bulbs are still there on the playfield.

Here's an idea of what this mod will look like (http://www.youtube.com/watch?v=1u_iDSINSfM) but with red LEDs, and only showing a single mode (the start of Paris in Peril, I think). This isn't my RFM, but has been done using the same method. Here is a video of my RFM (<http://www.youtube.com/watch?v=iZYqJpxuYug>) with the green LEDs but it's hard to see the SOL knockout saucer from this angle. If you search for the Bill Ung 'UFO Pinball RFM kit' on youtube, then compare the two. The UFO Pinball RFM mod has lots of scan patterns, whereas the mod given here is reliant on the playfield lights.

if you are still interested then let's get to it.

For each saucer, you need 8 x 3mm LEDs and 4 x 1K ohm 1/4w resistors. For wiring to connect the saucers to the playfield lights, I used a long (about 2M) Ethernet cable and cut it in half. This gives you the a 6 wire+ core that you need to run to each saucer in a neat cable. The Ethernet plugs will (just) fit down into the playfield. I used 6" of black heat-shrink tube at the saucer end to keep the wiring small and well hidden when running up from under the playfield. You need to remember to add the heat-shrink tubes to the cables **before** soldering them to the LED leads.



4 port RJ45 Ethernet PCB mount

On the underside of the playfield, I made a junction board out of veroboard with some RJ-45 8-way sockets which take the Ethernet cables. I used 4 x RJ45 Sockets, two at the top are for the Front Saucers, one is for the SOL hole saucer with one as a spare. If you can scavenge a 4 port RJ45 Ethernet module from an old Wifi or small Ethernet Hub) then that should work. If not, just use separate PCB mount sockets as I did and jumper them together.

There are two 12-way Male headers on the board. On the RH side you can see the original connector for game's COL 3-4B and ROW 3-7B Lamp Matrix. It used to be connected under the Light board for the Mothership in the middle of the playfield.

The middle connector is the **Female to Female 12-way** going to the underside of the playfield. The connections between the headers are simple and wired in in parallel 1:1 (meaning pin 1 to pin 1, pin 2 to pin 2, etc...). Pin 5 is the "Key" and doesn't need to be connected, so you only use 11 wires.

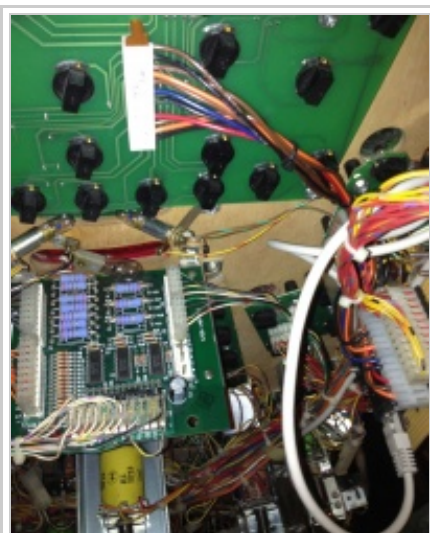
On the LH side the 4 black squares are the RJ45 sockets and connections. On my board, two face up and two down - but your layout could be different if it makes the wiring easier.

The RJ45 sockets are all wired to each other in parallel 1:1. Then wired to the header pins and so connected through to the LEDs to as per the instructions here. Lamp 9 (Row 3B) at pin 10 on the underside of the lamp board is not used for the mini-saucer LEDs, as there are only 8 LEDs on each saucer. Pins 3,4,10,11,12 must all "pass through" the headers/connectors so the playfield lights all continue to work but they don't connect to the RJ-45 sockets.



Board connections

Click a picture to enlarge, click again for even larger resolution. On most browsers use the back button to return to this page.



Playfield to Mod Board

This picture shows the 10" connector cable I made: A 12-way socket to 12-way socket .156". This connects the pins under the center of the Mothership lightboard to the pins on the mod board. Think of it like an electrical extension cord, which lets you "breakout" the pin connections you want to the LEDs without permanently modifying your game. I believe that when you add a mod it should be able to be "backed out" and the game put back to factory. It might be easier to splice into the cabling, but that's not *ever* the right solution in my opinion. A later game owner should be able to remove your mod board and plug the original connector back into the playfield.

Some critical notes about making up the saucers:

- Make sure you put the LEDs in the right way around to the diagram. The cathode (-) on an LED is the shorter lead, or the LED has a flattened side towards the cathode lead.
- Hold the LEDs in place with a *tiny* drop of superglue gel on the underside. You don't want watery superglue for this.
- **Don't forget to add the 4 x 1K current limiting resistors to the lamp rows on the underside of all saucers!**

You can swap two wires on the LH saucer to make it "spin" in the opposite direction. Make up the LH

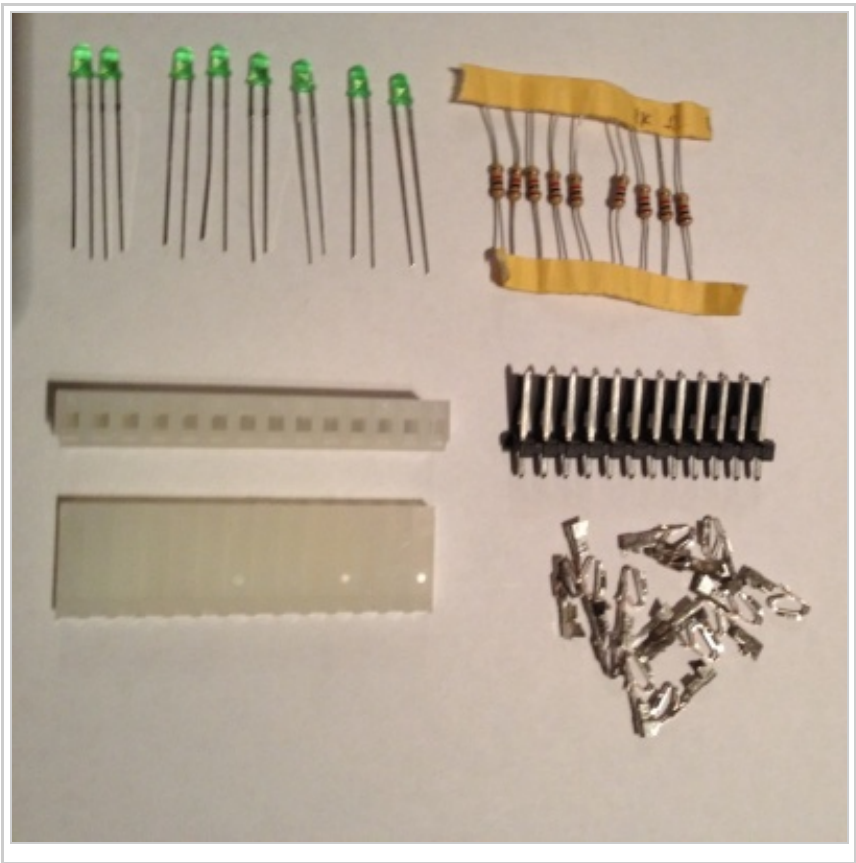
- Remember to put about 8" of black heat-shrink tubing loosely on the cables before soldering the LED leads. Then strip back the covering for about 6" arrange the wires together with a few twists and then slide down the tubing. It should go under the saucer edge and still cover the end of the Ethernet sleeve. Then and heat with a hairdryer. This makes it easier to hide the wiring on top of the playfield. The cable runs are easy, there are holes for wiring at the bottom of the slingshots and behind the SOL scoop which the RJ45 connectors will fit through, but test the ones you plan to use as the head sizes can be different.

Lastly, connect up the saucers to your junction board position them as you like on the ramps and enjoy the show.

The results from this mod are amazing, and worth the effort involved.

PARTS LIST

As a guess, the total parts should cost you < \$20, without adding the cosct of an extra saucer body for the SOL hole, as you would need to buy that anyway. Prices can vary. All the headers, wiring and vero board were in my pinball spares, so I only bought the 3mm green LEDs and 4 x RJ45 sockets when I did this mod.



Item	Quantity
LEDs 3mm (Cathode is the shorter lead)	8 Per Saucer
1K ohm 1/4w resistor	4 Per Saucer
12-way .156" Female Socket / Crimp Style	2 (Buy 20-way and cut to size)
Trifuricon Crimps (preferred)	24
12-way .156" Male Header	2 (Buy long strips with lock and cut to size)
Cable: Standard Ethernet 8-core	1 x 3M per Saucer pair (so two)
RJ45 8-way Ethernet Socket (like for CAT5)	3 (VBuy 4 and have one spare)
Pinball Header Wire	22-24 AWG (I believe that's a good size)
Hookup Wire	use the leftover 1/2 Ethernet cable twisted pairs

6 Repair Logs

Did you do a repair? Log it here as a possible solution for others.

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Category: Work In Progress

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