Pac-Man and Ms. Pac-Man Problems and Fixes
Version 1.0
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The following by Phil Morris:

Problem: Garbage on screen.
Diagnosis: Bit of an 'obvious' fault is this one, but even so it can be very easy to miss so I feel it's worth documenting – no activity at all on ANY of the CPU pins (except for the clock input). Simple fix – DIP switch 8 (Pause) was switched on!
Cure: Set DIP switch 8 to Off.

Problem: Board won't start up, nothing on the screen, no gameplay, dead. Also all the ICs on the lower row had very rusty legs, including the Z80 (Falcon bootleg – PAC-3).
Diagnosis: Checked the crystal – no pulse. Checked the two supporting resistors and one capacitor – all okay. Replaced 74LS368 at 9B as well as the Z80 – game fired right up.
Cure: Replaced 74LS368 at 9B (will also replace the rest of the badly rusted ICs as these are likely to fail sooner rather than later and/or lead to unreliability).

This board also had the Crush Roller ROMs loaded. On loading the Pac-Man ROMs the game wouldn't get past the test grid. However, Pin 2 on 9M (a 74LS367AN) was
Connected to pin 9 on 9N (a 74LS259) – removing this enabled the game to run correctly.

Problem: Boots, gets to the main screen then resets. Also can just see that there are two overlaid images, one the right way up, one upside down. If put into self-test mode will display that memory is okay but still with the overlaid right way up and inverted images, ALSO though with speaker noise and flickering white text with small black lines (Falcon bootleg – PAC-3).
Diagnosis: Board was modified to take Ms Pac-Man EPROMs (along with extra wires and piggy-backed EPROMs) so removed the set of EPROMs, removed the mods, replaced the 74LS42 at 7M (had a broken off pin 13 as part of the mod) and put in a set of good Pac-Man ROMs. Board then worked fine.
Cure: Removed Ms Pac-Man modified EPROM set, replaced 74LS42N at 7M and put in a proper set of Pac-Man EPROMs.

Problem: 10K volume pot very sensitive and crackly (Falcon bootleg – PAC-3).
Cure: Replaced pot.

Problem: Pac-Man 'death' sound effect has a noticeable hum.
Cure: None, perfectly normal.

Problem: Only blue colours showing, and white colours appearing blue (Falcon bootleg – PAC-3).
Diagnosis: Came about after replacing the LS157 at 3B, re-checked connections and pin 12 had lost its link to the track.

Cure: Re-soldered pin 12.

Problem: Ghosts and Pac-Man only appear in the lower half of the maze and when they get to the bottom their lower area appears at the top of the screen. When moving to the upper half of the screen they are invisible (for example, dots still disappear as Pac-Man eats them, even though his character remains in the lower part of the screen)
(Falcon bootleg – PAC-3).
Diagnosis: Used a logic probe to check the states of the pins on the 74LS161's at 1D and 2D – the state of pin 15 on 2D on the good board was reading Low and Pulsing, while on the bad board was reading High/Low and Pulsing.
Cure: Replaced 74LS161 at 2D.

Problem: Leftmost side of the display intermittently flickers (Falcon bootleg – PAC-3).
Diagnosis: Used my logic comparator to try and isolate any potentially failing ICs. Discovered that if the comparator clip was put onto the 74LS283 at 1E the problem stopped. Then used a logic probe on every pin on that IC and determined that with the logic probe on pin 5 the problem stopped. This pin is connected from pins 7 and 10 of the 74LS161 at 2N. Replacing either of these two ICs with new equivalents didn't resolve the issue. Found that using a 100 ohm pull-down resistor between pins 5 and 8 of the 74LS283 stopped the flicker, BUT a better solution (suggested by Mowerman – thanks Kev! ☺) was to use a 74HC161 at 2N in place of the LS161. This worked just great.
Cure: Replaced the 74LS161 at 2N with a 74HC161.

Symptom: board won't boot, gets part-way through the boot sequence and resets, but as the board warms up gets through less and less of the sequence. It was also sometimes putting up part of a 'BAD W RAM' error (Midway Pac-Man).
Diagnosis: This was a strange one. Put the board into self test and it identified the 2114 RAM at 4K as being faulty, so I replaced it and it worked fine, but for less than a minute. So, as the problem was getting worse as the board warmed up I applied freezer spray to assorted components. Turns out that applying the spray to the 74LS139 on the Sync Bus Controller (SBC) daughterboard was enabling the board to boot, but only for a while. Once it had warmed up the problem occurred again and the board started to reset. Another red herring was the fact it sometimes reported assorted 'BAD RAM' errors (BAD VRAM, BAD WRAM, etc) even in test mode. Anyway, decided to replace the 74LS139 on the SBC. Put in another 74LS139 and the fault was even worse, just displayed garbage on screen! So, decided to try a chip that sucked less power, namely a 74HC139, and that worked just fine!
Cure: Replaced 74LS139 on Sync Bus Controller with a 74HC139 (note: I've now had two SBC's with exactly the same problem/fix).

Symptom: Display has a lot of distortion in the form of graphics being distorted vertically (up and down), sprites misplaced and various brief speed-ups. (unknown bootleg, dual boardset, labelled as PAC-2).

Cure: Replaced 74LS161 at 3R.

Symptom: Fine dotted white lines directly above and below all text.
Diagnosis: Discovered that heating up the colour PROM at 7M caused the lines to all but vanish, and cooling it down caused the lines to re-appear. Swapped the PROM with another and if anything it was worse! I now intend to swap the only remaining suspect, namely the socket (it's an old and somewhat poor looking single wipe DIL)
Cure: unknown, but possibly the socket for the PROM at 7M. Update: could also be down to the speed of the PROM. Will try another when time allows.

Symptom: Everything looks like hieroglyphics, but text and characters can just about be made out (bootleg, labelled as PAC/M).
Diagnosis: This board has been badly made and badly stored, many traces disintegrate as soon as a soldering iron touches them. Anyway, investigation revealed that the 74LS283 at 1F was at fault.
Cure: Replaced 74LS283 at 1F.

Symptom: All sprites (ghosts, pac-man, etc) cut in half and spread about 4 wide across the screen.
Diagnosis: Pin 4 of the LS283 at 2F was stuck high (I think – might have been low!)
Cure: Replaced the 74LS283 at 2F.

Symptom: Ghosts are very bitty and 'streaked', also misplaced at the very top of the screen (bootleg labelled as PAC/M).
Diagnosis: Checked all the relevant video-related 74LS161 counters and discovered that the one at 1E had dead outputs.
Cure: Replaced 74LS161 at 1E.

Symptom: Any MOVING sprites (as opposed to static ghosts on the attract screen) have vertical lines going through them (bootleg, PAC-2).
Diagnosis: Spent ages trying to fix this but got nowhere. However, it has been suggested that I tweak the voltage up to 5V (as high as 5.2 in fact) as the board is currently getting about 4.80. However, my ATX PSU only goes up to about 4.85 if I adjust the internal pot with this PSU plugged in, so will need to get someone else to try it for me.
Cure: Unknown at present, but might need a slightly higher voltage.

Symptom: Board won't boot, gets part way through the boot process then resets.
Diagnosis: Noticed that progress through the boot process was getting less and less as the board warmed up, so thought I'd try applying freezer spray to all the components. After applying spray to the 74LS139 on the Sync Bus Controller (SBC) the board booted! So, swapped out the LS139

with another, but it still wouldn't boot and if anything was worse, ie it didn't get so far through the initial boot-up sequence, even with freezer spray applied (which helped, but not enough). Decided to try a 74HC139 instead of the 74LS139 and it worked!
Cure: Replaced 74LS139 on the Sync Bus Controller with a 74HC139.

Symptom: Board won't boot – static screen (that immediately clears) of zeros and maybe assorted other numbers/letters/sprites (Midway Pac-Man)
Diagnosis: checked out all the usual first, voltages, ROMs, checked for power shorts, etc. Took an AGE to fix this though. Eventually after much continuity testing of data lines, etc it turned out that the AB6 line (which starts at pin 11 of the 74LS367 at 6R) was shorted to +5 volts DC via a small blob of rogue solder. Trouble is, after resolving this the board STILL wouldn't boot, but there was different alternating garbage on the screen. Continuity tester in hand I continued to check out more signals and it turned out that the AB11 line (starts at pin 5 of the 74LS367 at 6R) wasn't getting to pin 13 of the 74LS139 at 5L. The signal was coming out of the 367 put there was a problem with the Plated through Hole (PTH) right next to the pin – cleaned it out, put in a bit of wire and some solder and the game fired right up!
Cure: See diagnosis above for details.

Symptom: Board won't boot – displays a screen full of flickering letter C's interspersed with flickering dots and dashes and sometimes other letters.
Cure: 2114 RAM at 4H was faulty – replaced.

Symptom: Green 'speckles' were visible whenever sprites on screen, also black dots within all sprites and text colours fluctuating (i.e., letters consisting of multiple simultaneous colours). note: this was a Jeutel copy board, using the usual daughterboards for the Sync Bus Controller (SBC) and VRAM Addresser.
Diagnosis: Symptom seemed to be worse when the board was cold, so paused the screen with some speckles/dots visible, let the board warm up them used freezer spray on all relevant video related ICs. Determined that the SN74LS375 at location 3C was at fault (note: this location isn't always populated – it depends on whether locations 1A to 1D are populated or not (they were in this case)).
Cure: Replaced SN74LS375 at location 3C.

Symptom: Garbage on screen, no gameplay (bootleg dual boardset).
Diagnosis: On checking the pins of the Z80 with a logic probe, saw that pin 26 (Reset) was floating. Also noticed when probing pin 26 that the screen display sometimes changed as if the board was starting to boot. Traced pin 26 of the Z80 back to pin 13 of the SN74LS02 at location 7L – all inputs were okay so chip was suspect. Replaced the chip and she booted right up.
Cure: Replaced SN74LS02 at location 7L.

Symptom: Colours wrong but PROM okay (bootleg dual boardset).
Diagnosis: This board had been hacked to play some other game and the resistors at R16 (should be 220 ohms) and R17 (should be 470 ohms) had been replaced. On putting back in the correct values the colours then reverted to what they should be.
Cure: Replaced resistors at R16 and R17.

Symptom: Bottom half of maze missing, in its place is the top half of the maze (bootleg Falcon FPM-3 board).
Diagnosis: Checked the ICs above the two columns of EPROMs (these ICs would normally be present on the VRAM Addresser board if looking at an original Midway board). The SN74LS02 at location L5 was found to have pin 4 stuck Low.
Cure: Replaced SN74LS02 at L5.

Symptom: Sound effect for eating a ghost was distorted (thanks to Geoff Gunn for this).
Cure: Replaced the SN74LS174 at location 1L.

Symptom: Fine lines of grey 'speckles/dots' under characters and text.
Diagnosis: Noticed that the problem slowly faded away as the board warmed up and that heating/cooling the colour PROMs at locations 4A and 7F caused the problem to get better/worse. When probing (with a logic probe) the address lines and outputs of those PROMs the speckled/dotted lines also diminished noticeably. Tried replacing the PROM sockets and the PROMs themselves but to no avail. Eventually put a 70-ohm pull-down resistor onto pin 13 of the PROM at 7A, which considerably reduced the fault.
Cure: Put a 70 ohm pull-down resistor onto pin 13 of the PROM at 7A.

The Following by Mike Haaland:

Problem: Ghosts and Pac-man are composed of the same right half of the character, this only happens on Moving characters, the Pacs at the bottom of the screen and the Ghosts on the top of the intro screen are fine.
Fix: Stuck output on 74LS86 pin 6 at 2H. This is easily reproduced by shorting pin 6 and pin 7 together on this chip.

Problem: Entire screen is composed of A's, the Ghosts are part of Super Pac-man, game plays fine.
Fix: Replaced bad 74LS273 at 4D with stuck outputs.

Problem: Strange lines throughout the images even when switch 8 is on.
Static appears also when the game is running (switch 8 off).
Fix: Replace the 74LS368 at 8E, pin 10 was rusted and falling off.

Problem: No Moving characters on the title screen. No Moving characters during gameplay.
Dots visible & disappear as eaten.
Fix: Broken trace between 7420 @ 3E, pin 8 and 74LS174 @ 1H, pin 4.

Problem: The board would cycle between the 2 screens. Staying on the 2nd about 3 or 4 seconds,
then reset and display the 1st for an instant. Wash, rinse, repeat. :)
Fix: This was a compound problem. Both 284 and 285 sockets were bad causing the reboots and
the rams at locations 4K & 4L were bad causing the garbage on the screen.

Problem: All motion graphics repeat horizontally.
Fix: Shorted trace to jumper pads on backside of board at location 1A, pins 3, 6 and 7.

Problem: Maze is consistently messed up in the same areas.
Fix: none yet.

Problem: Mixed up graphics. Graphics repeat at odd places on the screen.
High score section is written in the left half of the screen vertically from the bottom up.
Fix: Broken traces to the 284 card. A8 was floating.

Problem: I had Multiple boards with the same problem. Pac-man and Ghosts split in two as they
move across the centre part of the screen. Also characters sometimes appear at 2 places at once.
Fix #1: Replace 74LS283 at 2F
Fix #2: Replace 74LS20 at 3E
Fix #3: Broken pin 5 on 74LS00 at 4C. I had 3 like this, they were Driving Force conversions at
one time.

Problem: Then entire playfield is filled with alternating coloured horizontal lines.
Fix: Bad 2125 rams. Replaced them all at 2A, 2B, 2C, 2D. There was "goo" under them
causing all kinds of shorts between legs. After cleaning them off, only 2A was actually bad.

Problem: Two of same sprites on the screen at the same time. Two Pac-men on screen.
Fix: None yet.

Problem: Red horizontal lines through the entire screen.
Fix: Bad RAMS at 2B and 2D, both 2125s.

The following by Mark Spaeth:

2000-09-10:
(Bootleg Ms. Pac-Man boardset, 2 PCB split stack, VRA, SBC incorporated onto the main PCBs,
6-prom wiring hack to make it a Ms. Pac-Man)

Goes through startup sequence, writes 'MEMORY OK' then resets. Resetting is sometimes (but
not always) due to the watchdog.

ROM Check: Ms Pac-Man Bucco bootleg ROM set (via romident)

This hack looked pretty poorly done, so I'll undo it and replace it with the single prom Ms. Pac
hack.

Done... board works fine.

I'm guessing it was a socket problem.

2000-09-10:
(Original Pac-Man PCB)

Static blank screen, with 4 sprites scattered.
Pin 13 of the Sync Bus Controller was bent out, fixed.

Same 4 sprites on the screen now, with blinking trash in the background.
Game apparently is NOT resetting. Bad RAM?

Tested the 6 2114's at 4KLMNPR and the 2 at 4L and 4M were bad. Swiped
RAMs off a handy nearby omega race, tested them, and dropped 'em in.

Now the screen is full of yellow and blue arcs that seem to change colours back and forth
randomly... quite pretty, but not very playable. CPU still isn't resetting.

It looks like there's still some sort of RAM error going on...

Seeing the same thing on the screen everywhere makes me suspect some of the interface chips
between the RAMs and the video output. (i.e. the 74245 at 4H, the 74273 at 4D, the 74377 at
4B).

Pulling the 74245 @ 4H, I see a brown spot under it on the board, which is a pretty good sign it wasn't happy... threw in a socket, dropped in a fresh chip, and the board came up with the same sort of pattern, but all yellow.

Looking at 4D, it's obvious someone tried to replace it before, and didn't socket it. Shoddy workmanship. Pulling the 74273, 4 traces come up with it. (remember what I said about it not being socketed!) Threw in a socket, repaired the traces (pulled them up back to a via/pad and soldered wire from hole to hole) and dropped in a new 273.

Now the board comes up and does the sprite test on top of the yellow arcs then watchdogs -- I think that's progress (?)

I'm officially bored with this board, so I'll throw it back on the dead pile.

2000-10-12:
(Original Pac-Man Board)

Game comes up and plays, but the screen is all messed up. In general, the background is jittery and in placed doubled in the H direction. Sprites moving vertically, seem to jump rather than move smoothly. Sprites seem to suffer varying offsets in the V direction. Entire image suffers from noisy random colour changes.

Already socketed from earlier repairs: 1F, 2F, 3D, 3F, 3H, 4B, 4D. (The chips in the sockets don't necessarily look new, though).

Most of the problems should be in the graphics output circuitry. The 74245 at 4H must be good, or the ram tests would fail.

I'll attack the sprite problems first, since changes there are a little bit easier to see. The jumpiness when moving horizontally probably comes from the match circuit. I'll check the V signals going into the '283s, and perhaps the 74174 that follows them.

Looking closely at the '283, I see that pins 1 and 2 are shorted by a solder blob on 1F. Cleaning that up fixed the jitters and doubling in the H direction. The other goofy problems remain. I guess I'm fixing the wrong problem... oops :)

The colour glitches appear in the background only, not the sprites. Thus, I'll assume 2A/B/C/D, 3A/B/C/D, and 4A/B are fine. And most of the decode logic for the video roms are OK. Actually, since the ROMs for sprites and background are different, it could just be the 5E rom acting funky. 5E reads and tests fine via romident, but the board accesses data much faster than the burner. Dropping in 5E from another board, the colour glitches are fixed. Woohoo! (Should have tried that sooner ;)

The horizontal jumping has to be a problem with the match circuitry. After a lot of poking around, I found that when 1F was socketed the trace to pin 11 that runs between pins 6 and 7 broke and part of it got shorted to pin 6. Pulled off the socket, repaired the trace, replaced the socket. Voila.

Another pac saved from the dead stack.

2000-09-14:
(Original Pac-Man PCB)

This board flashes garbage for a second (whatever's in the video ram before the CPU clears it) then shows only a black screen. There's no sign of any sprites being displayed. The CPU is not resetting, and the watchdog circuit is getting kicked.

Looks like a ram problem offhand so I'll test the 2114's. They all test out OK in another board, so perhaps the RAM interface circuitry.

I'll start by swapping 4H, since I've seen it go bad on other boards. That didn't help... seems to be a problem with bad program rams, so we'll try changing bad sockets. Swapping out the socket on 4M got the board going... for about 5 minutes, then it crapped out and started doing the same thing again! Bit 2 seems to be the problem...

2001-03-01:

Yes, same board... heh... I think... symptoms are the same at least. Doing a code trace, the ram test writes 0x0f to 0x4c00 and reads back 0x0b. I'd guess that bit 2 is bad, but I investigated that above to no avail, so let's see when 0x0b is written to some address in the 0x4c00-0x4fff range. Aha! At 0x4c04... maybe A2 is having problems instead of D2... And swapping a '367 for A2 fixed it...

But the graphics are still fuxored. I'll start by swapping the 74283's, since it looks like I'm getting erroneous vertical matches... but I don't have any spare parts... Bah.

2001-03-03:

283's didn't help, so I swapped the 7489's and the 7420, and everything's happy now... for completeness, I'll swap the chips back and see which were actually bad. I'm guessing it was the low-nybble 7489. Test indicated I was right... heh. Cool.

2001-03-02:

This is probably a board I looked at before. It comes up and does the "sprite roll" then just flashes some junk on the screen. All the rams have been replaced, so they should be fine. A

short code trade make it look like there's a ram interface problem, since the program ram isn't working well enough for the subroutine call that prints bad ram to return properly. Doh! This nastiness we see on the screen is supposed to be the '1' for "BAD C RAM 1" but it's getting munged somewhere along the line. Looks like bit 7 could be stuck high.

Hmmm... the socket job on the '245 at 4H looks really crappy... I'll redo it... and voila. Guess I'm out of non-stripped dead pacs :(Pisser.

2001-05-05:

Dead pac from Steve W. No video and no sync signal. No real signs of life in general except a click from the speaker when I power it up. I'll start by at least getting garbage video. A little probing reveals that the 74107 at 8A is probably bad. (Although the 74368 at 8B is also suspect.) I'll swap them both. Swapped 'em and now I have video, but the screen is garbage.

Burned new video roms, and stuck on a 4-1 Pac-Man rom board and it works fine!

Bitchin.

2001-11-15:

I know I've worked on this board before, but I guess I never wrote anything down about it. It works fully, but the sprites are all screwed up, and are split into 16 different lines across the screen. /MATCH should be OK. The 7489's are socketed, so I've replaced those. The 161's are socketed, so I've replaced those. Several other random chips have been socketed, but probably not by me.

Brainstorm: Check the frequency of the /LD on the counters, to see if it's only loading as often as it should be (60 Hz * 6 sprites * 16 lines). Nope, it's 16khz, so that's obviously a problem. Checking frequencies in the circuit leading up to the /LD, I find that the trace from 2P:x to 4C:10 is broken. Repaired the trace and the game lives.

Cool. This one had been bugging me for a while, if I remember correctly.

The following by Matt McCullar:

Problem: Game plays great, all sounds work, maze looks fine, text is okay, etc. But Ms. Pac and the monsters are upside-down! Again, everything plays just fine, the monsters go where they're supposed to and all, but all the moving objects (including the fruit!) are upside-down!!!!

Fix: At first I thought it was a problem with one of the daughtercards, but changing those did nothing. It was not a 2114 RAM problem, nor was it a ribbon cable problem, a ROM problem, etc.

Turned out to be a bad 74LS157 at location 4E on the motherboard! This is a quad, dual-input multiplexer and the output on pin 9 was stuck to one input. It wouldn't change to the other input when it was supposed to. This chip handles the "FLIP" signal, which inverts various things on the screen when the board is in cocktail mode and it's Player 2's turn.

Ran across a very strange problem on a Pac board yesterday and thought I'd share it with everybody. If it happened to me, it can happen to you.

Bally/Midway used several different styles of resistor networks during their production runs of *Pac Man* and *Galaga* boardsets. Resistor networks are integrated packages of individual resistors. They are usually of the same value, usually tied together at a common pin. These networks are often used to provide extra current for data busses; without them, inputs to TTL chips may be left "floating," and strange things can happen.

The blue/white ceramic networks cause the most trouble, followed by the light brown ones. Individual pins separate from the substrate, leaving one data line not being pulled high, while the others function normally. Or ALL of the resistors may become isolated from five volts when the common pin breaks internally.

It's a good idea to replace all of these networks whenever you're servicing a board, especially if it's 20 years old. It may not be necessary, but at least you won't have to worry about it, and it doesn't really take very long. I like to replace them with discrete resistors... but that's just me. If you can get a good deal on the various sizes, shapes, and resistance values that populate a board, then by all means please do so.

I found a very strange failure on a 1-k resistor network on a Pac board yesterday that I've never seen before. When you remove it, you're supposed to get 1k of resistance between each pin and the common pin (usually pin 1). On this one, however, I got only about 500 ohms between a couple of the resistors and the common pin! They were not shorted together, but had changed their resistance dramatically. Very strange. I don't know if I'd have found this if I hadn't been replacing all of the networks as a whole.

Problem: Ms Pac-man displays 7 lines of vertical garbage
Fixes:
  • Check the ribbon cable. This goes bad quite a bit.
  • Make sure you're getting clock signals out of all of your 74161/74163 counters. These generate the H and V timing signals, and if one of them is missing, all sorts of weird things can happen because most of the rest of the circuitry is driven from these.
  • Check for bad resistor packs, particularly if they're of the blue & white ceramic type.

- Look beneath the board and clip off all long leads that are folded over and/or shorting against something else.
- Are all the chips really getting +5 volts? There may be a power supply problem.

Problem: Sounds during self-test, but not during game:
Fix: Replace 74LS259 at 8K.

Problem: Had a Ms. Pac motherboard that worked great on the bench, but went NUTS in the cabinet. I measured the +5 volt line and saw it was quite low... constant resetting, coin counter chattering away, the works.
Fix: Care to guess what caused all this? The darned filter board that plugs into the edge connector!!! Whenever I removed it and plugged the cable harness directly into the motherboard, it started right up and played great. Put the small RFI filter board back in, back we go into gonzo mode.

I figure the contacts in a connector aren't making good contact. The game plays just fine without it, and I'm beginning to understand why people get rid of them so often. :)

Problem: The game boots normally, but in attract mode, the ghost come on screen, and then half way across, they disappear, and then re-appear down by the Midway logo. Each ghost repeats this, and eventually all four are lined up down by the Midway logo (just like they would normally be beside the main title box). Game coins up and plays, and the same things seems to happen, Ms Pac and the ghosts are moving outside of the maze, as if the foreground has become shifted down and to the right of the background.
Fix: Check 74LS161 at 3F and 3H. Replaced the 7489 at 3F.

Symptoms: Intermittent garbage in certain areas of the screen... Game plays, but in certain sections, particularly in the exact centre of the playfield, a single row of pixels would be missing from moving objects (such as monsters). Symptoms never changed. Changing out 2114 RAMs, the attack RAMs, the EPROMs, daughterboards, Z-80, sockets, did not help.
Fix: The problem turned out to be a bad 74LS161 chip at location 2S. This is a four-bit binary counter that generates the V signals. Pin 12 was "ringing" instead of putting out a nice, clean square wave. Looking at it with an oscilloscope, it appeared to be another signal riding on top of the usual square wave.

The following by Jim Skilskyj:

Measurements of some chips on Pac-Man when it is running the attract mode.
Last updated 1/26/99

IC	Pin	Signal
8A	2, 3, 5, 6	6 MHz
8B	7	18.4 MHz
8C	5, 6	3 MHz
8C	9	~16ms Neg Pulse
3R	7	1 MHz
3R	14	1.534 MHz
3R	13	0.767 MHz
3R	12	0.383 MHz
3R	11	0.191 MHz
3S	14	0.0959 MHz
3S	13	0.048 MHz
3S	12	0.016 MHz
3S	11	0.016 MHz
7N	12, 13, 14, 15	Full Signals _|-|_|-|_
7N	1 , 2, 3, 4	Pulse Signals _|_|_|_
7M	10, 11	Negative Pulse
7L	13	Reset=Low, Run=High

Troubleshooting the sound:

Here is a small list of some signals to check for when troubleshooting the sound circuit of a Pac-Man/Ms. Pac-Man. I used the insert coin sound for testing:

IC	Pin	Signal
3K	4, 7, 9, 12	Data signal with and without sound generation
3K	1	1.534MHz steady
3L	1	1.534MHz steady
3L	4, 7, 9, 11	Data signal with and without sound generation
2L	3	High with low pulses
2L	5, 7, 9, 11	Slow pulse, data signal with sound generation
2K	5, 7, 11	Data signal
2K	9	Low signal usually, sometimes data pulse
2K	3	287.8KHz steady
1L	9	Pulse, data signal with sound
1L	3	Pulse, data signal with sound
1L	5, 7	95.9KHz steady, modulated pulse with sound
1L	10, 12, 15	95.9KHz steady, Modulated pulse with sound
1M	9, 10, 11, 12	Low, data signal with sound
2M	1	High
2M	12, 15, 16, 19	95.9KHz intermittently (generate sound to see)
2M	2, 5, 6, 9	95.9KHz with sound
1N	2, 3, 9, 10	3V, signal with sound generation
1N	5, 6, 12, 13	95.9KHz steady with sound generation
3M	9, 10	287.8KHz steady
3M	11, 12	1.246MHz steady

9/3/01
Problem: Pac-Man that would not sync with AC power but would with +5VDC power.
Fix: OK this was an odd one, it would not sync horizontal or vertical if it was used in an actual cabinet, but would work fine if I hooked it up on my work bench (using an IBM AT power supply). I also noticed that if I hooked the +5V directly to the +5V PCB rail, it would work but if I pass it through the diode it would fail. I then looked at the sync output on pin 11 of IC 5M the 74LS08. The output was there but it was riding high, never going below 4VDC, the inputs on pins 12 and 13 looked fine. Replacing the chip fixed the PCB.

9/3/01
Problem: Pac-Man with odd sounds.
Fix: I best description of what the sounds were like is that the pitch was too high and the harmonics were "off key". To troubleshoot this one I used the coin up sound (repeatedly) to test

the circuit. On the first pass of poking around with the scope, I did not see any missing signals, so I replaced both 7489 RAM ICs. Doing this corrected the sounds. Retesting the chips I found that IC 2K was bad.

4/12/01
Problem: Ms. Pac-Man with sparkles in characters.
Fix: The Ms. Pac-Man and ghost characters had white pixels where a solid colour should have been. This is usually a sign of having a bad character ROM. Sure enough; replacing ROM 5E fixed the problem.

2/14/01
Problem: Ms. Pac-Man with nothing but a 2 on the screen.
Fix: This board when powered up would simply display a 2 on the screen, nothing more. I first removed the Ms. Pac-Man satellite PCB and inserted a Z80, this did not change the operation at all. I then went for the ROMs and found that ROM 6J had a missing pin (this was a mask ROM with the usual blackened legs). Replacing this ROM now allowed the game to come up to garbage on the screen, not much of an improvement, huh. So I checked the other two masked ROMs (the fourth ROM was an EPROM) and found that a leg or two was also missing from each. I replaced those with EPROMS and now got the crosshatch pattern but then it would lock up here. I accidentally bumped the Sync Buss controller PCB and wham, Pac-Man came up! Replacing the IC socket fixed that problem.

8/12/00
Problem: Pac-Man with multiple images and scrambled sprites.
Fix: Since there seemed to be some sort of addressing problem, i.e., double vision graphics etc. I poked around the 28-pin connector on the VRAM addresser (284 module at 5S) with the scope. I found that two pins looked odd, about half of the activity of the rest of the pins around the socket. Pins 19 and 20 seemed to have very little activity compared to the rest of the address lines. I flexed the satellite board while watching the signals and found I could restore them. Replacing the socket on the MLB fixed the problem.

8/12/00
Problem: Pac-Man board with garbage and flashing number 1 in upper right of screen.
Fix: This board had the Two Bit Score MultiPac boards installed onto it. This was not the cause of the problems however. A number with nothing else usually means a bad 2114 RAM IC. In this case it was IC 4R, the first IC (under the VRAM addresser) in the row. Replacing this chip fixed the board.

2/19/00

Problem: Pac-Man with all characters running along the top of the screen.

Fix: This board had two problems actually; one was that the maze was duplicated left and right as well as the 1 UP/SCORE was down the middle but backwards. The other problem was that all characters were running along the top of the screen only. The problem with the maze was a pin not seated in the socket on the V-RAM addresser board. The character problem was a bad 74LS161 counter at location 1E. None of the four outputs of the chip had any signal.

1/17/00

Problem: Pac-Man with odd sounds.

Fix: I can't describe what the sounds were like exactly except the pitch was too high and the harmonics were "off key". To troubleshoot this one I used the coin up sound (repeatedly) to test the circuit. On the first pass of poking around with the scope, I did not see any missing signals, so I replaced both 7489 RAM ICs. This did not fix it, so I went back to the scope and compared address and data line signals through the circuit. This is where I found/noticed a difference on one of the signals. Pin 12 of IC 1L (74LS174) had a 95.9MHZ signal but did not change when I generated a sound, yet the other flip-flops D outputs (pins 5,7,10, and 15) gave a sort of modulated 95.9MHz signal. Replacing this chip fixed the game. Thanks to Shawn Morelan for allowing me to fix his board.

1/4/00

Problem: Pac-Man that just cycles the diagnostics.

Fix: This board would only cycle the diagnostics and the screen had a 2-inch wide area of vertical garbage within the test patterns. I first replaced the 2114 at 4K. This fixed the vertical garbage, but the game still cycled. I then touched/twisted IC 4L and it caused different garbage. I cleaned the pins but that didn't fix it. So I replaced IC 4L, this fixed the game. I thought it was bad sockets since pressure changed the symptoms, but it wasn't. I put the chip in a different known good Pac-Man and the chip still failed when I put pressure on it!

8/25/99

Problem: Pac-Man with lost horizontal sync and no game play.

Fix: Poking around with the scope and using the frequency list I found the 3R and 3S (74161) had wrong frequencies. Pin 14 of 3R looked very odd. I first replaced 3R (it was socketed already) but this did not fix it. I followed the trace to pin 1 of the V-RAM addresser board. I found that pin 1 of the socket on the V-RAM board was shorted to a trace going to pin 9 of a 74LS157. Removing this short fixed the game.

8/19/99

Problem: Pac-Man with garbage and random sounds.

Fix: The garbage looked unrecognisable, no complete sprites at all. Looking at some signals with the scope I found that one of the 2114 RAM ICs had no signal on pin 7 (address line). Twisting

the RAM ICs in their sockets caused a variety of garbage changes. I got a screen full of Fs at this point. Replacing all of the orange sockets for the 2114 RAMs fixed this board.

6/15/99
Problem: Pac-Man with garbage on screen.
Fix: When looking at the signals off of the Z80, most of them only varied between 0V and 1V. Since both address and data lines were local to the Z80 only, I replaced the Z80. It now ran but the background was red instead of black. Replacing the colour PROM (82S123) fixed the colour problem.

2/22/99
Problem: Pac-Man that would only show a few sprites and freeze.
Fix: There was no activity anywhere. Poking around I found that there was no interrupt happening on the 74LS161 going to the Z80. I also noticed that pin 4 of the 74LS259 was stuck low (8K). I thought this was the problem, so I replaced the chip. It didn't fix it. I then pulled pin 4 of 8K out of the socket and tied the input of the 74LS08 (7H) high, which is where pin 4 of 8K connected to. This gave me an entire diagnostic boot cycle all the way to "RAM OK", after that it would reboot. At least I knew where the problem was but didn't know what was causing it. I then looked at the MLB closer and found a short between two traces on the board. The short tied pin 13 to pin 14 of IC 8K together. This caused no output on pin 4, which disabled IRQ during vertical blank. This is the signal that enables the interrupt through the 74LS161.

2/15/99
Problem: A high-pitched squeal all the time and when playing, the sounds were off colour/weird.
Fix: I found that pin 5 of IC 2L was stuck high, this is a 74LS89/82S25N RAM IC.

2/15/99
Problem: No display or sound. No signal activity anywhere except on the crystal itself (18.4320MHz).
Fix: Replacing IC 8B, the 74LS368 hex bus driver, fixed the board.

2/15/99
Problem: The ghosts would not follow the maze, they would jump all over the place and such.
Fix: The video problem was traced to IC 3H, pin 11 was stuck high. This is also a 74LS89/82S25N RAM IC. This board now works.

1/29/99
Problem: Only displayed a few sprites upon power up with no self-test or other activity.

Fix: Looking at pin 13 of 7L, I found a slight pulsing square wave but it never went over +1V (invalid TTL level). This is the reset line to the processor. Replacing the 74LS02 (7L) fixed the game.

1/11/99
Problem: This is a Pac-Man with modifications to allow 2532 ROMs to be installed to play Ms. Pac-Man (no satellite board). This game board had no video output at all.
Fix: I started looking for missing signals with the scope. I found that the control lines and most of the Z80 lines had little or no activity. Control lines 1H, 2H, and 3H had no signal (tied to ground). Thunking reset showed that the Z80 was giving small bursts on the lines, except the above-mentioned control lines still would not do anything. Replacing IC 3M (custom IC for sound data) resolved this problem, I now had video garbage on the screen. A big improvement but still non functional. Upon further inspection, I found that there was incorrect ROMs installed, some Ms. Pac-Man, some Pac-Man. However this didn't fix it, now I have different garbage. I took a closer look at the modifications and found an error. Pin 9 of IC 7L was cut which caused the last two added ROMs to not be seen properly. Adding a jumper wire fixed the game.

1/11/99
Problem: This game showed the static characters but the four ghosts along the left side had part of a Midway logo instead. Also there were no moving characters at all. The maze and dots show and dots disappear as the invisible Pac-Man would eat them.
Fix: The fix for the ghosts being logos was that the character ROMs (5E and 5F) were Ms. Pac-Man, not Pac-Man. The other problem was a bit tougher to figure out. I looked on the scope for any missing signals but did not find any. Looking at the schematics, I was sure it was in the circuit surrounding the RAM ICs 2A-2D and the output multiplexers for the video. In looking at the binary 4 bit counters at IC 1E and 1F which are 74LS161s, I found strange output frequencies. I had my freq counter hooked to my scope and found that the counter was not counting properly at all. I.e., it should be 3MHZ, 1.5MHZ, 0.75MHZ, and 0.375MHZ on the four outputs. Replacing IC 1E fixed the missing moving characters.

The Following by Kev (Lawnmowerman):

Kev's excellent site has loads of information on Pac-Man/Ms Pac-Man, hardware, switch settings, etc. Go here:

http://users.erols.com/mowerman/pacfile.htm

Ms Pac-Man Modification (Falcon board)
written up by Phil Morris

Note: this is based on removing said mods from a board and there is a chance that I missed something, so use at your own risk!

By default these Pac-Man boards don't have enough program sockets (only four) to accommodate the six 2732's required for Ms Pac-Man. There are various ways around this, one is as follows:

1. Take the six original 2732's (or 2532's) with the Ms Pac-Man program code.
2. Plug the first four (bottom to top) into the relevant sockets in the sixth column, so leaving EPROMs '5' and '6' un-socketed.
3. Take EPROM '5', bend out pin 20 and place the chip into a 24-pin socket (leaving pin 20 OUT of the socket).
4. Take EPROM '6', bend out pins 20 and 21 and place the chip into a 24-pin socket (leaving pins 20 and 21 OUT of the socket).
5. Now carefully position the socketed '5' EPROM **OVER** the '3' EPROM (already in the board) and solder all the pins from EPROM '5's socket onto the pins of EPROM '3'.
6. Now carefully position the socketed '6' EPROM OVER the '4' EPROM (already in the board) and solder all the pins from EPROM '6's socket onto the pins of EPROM '4'.
7. Wire pin 20 of EPROM '5' to pin 5 of the 74LS42 at 7M.
8. Wire pin 20 of EPROM '6' to pin 6 of the 72LS42 at 7M.
9. Wire pin 21 of EPROM '6' to pin 24 of EPROM '6'.
10. Detach pin 13 of the 74LS42 at 7M from its' pad, bend it out and wire pin 5 of the Z80 CPU to it.

That's it, all done

Jumpers:

Looking at the board, parts side up with the edge connector pointing down, just above the edge connector there is a row of SIP pull-up resistors, above that a row of discrete current limiting resistors and above that, a row of debouncing ceramic capacitors.

At the right end of the discrete resistors and caps there are four sets of pads that are unpopulated. Actually, the second set from the end may have a wire or zero ohm resistor from the upper end of the resistor connection to the upper end of the cap connection. This is the cocktail/upright jumper. Remove it to obtain upright operation.

The set of pads at the very right-most end is the test mode jumper position. Install a jumper or a switch just like the CT/UR jumper to use this mode. It is hot switchable and the settings are hot changeable. Activating the stick, buttons and coin chutes will give sound tests.

The 2 other sets of pads are extra coin chute switches. Use them at will. There does not appear to be any 'statistics' mode so it doesn't matter which chute coins are inserted into (like it ever does?).

Links

Kev's Pac page: http://users.erols.com/mowerman/pacfile.htm
Mike Haaland's page: http://www.mikesarcade.com/
Mark Spaeth's page: http://rgvac/978.org
Jim Skilskyj's page: http://www.geocities.com/SiliconValley/Horizon/2253/
Phil doesn't have a web site as he's too busy to maintain it properly ☺