

Commodore PET 2001-8 Repair and Refurbishment

Alan Griffiths – October 2021

INTRODUCTION

The subject here is a relatively unmolested first generation PET 2001 with chiclet keyboard which had been in dry storage (spare bedroom) since acquisition about thirty years ago. At the time of purchase the PET would power up but just displayed a screen full of random characters. I now know that this is a classic failure mode for machines of this genre.

This is effectively a summary of a somewhat tortuous [thread](#) from earlier in the year and I'm hoping it will provide a concise overview of this PET's return to health.

INITIAL ASSESSMENT

1. Apart from a light gathering of dust the PET was in generally very good condition internally and externally despite its many years in hibernation.
2. Paying particular attention to electrolytic capacitors I could see no signs of physical deterioration of components on the motherboard or the monitor's PCB. The PSU's smoothing capacitor looked fine too.
3. There was no evidence of any previous repair work and all the components looked to be original.
4. Cosmetically the only real downside was a group of unsightly scratches on top of the monitor.
5. The original built in datassette was missing and its exact whereabouts remains unknown (dark corners of the loft!).

APPLYING POWER

Bearing in mind that the PET hadn't seen power for about thirty years I fired it up via its linear PSU using a Variac whilst monitoring the current drawn. At 230V the current stabilised at a reassuringly steady 240mA and the screen displayed random characters just as it had done all those years ago.

Having verified correct voltages on the four regulated supply lines, the unregulated voltage and the supply to the monitor serious fault finding could begin.

RESEARCH

For me fault finding generally starts with research and this was particularly so here as I had very limited past experience when it came to repairing micro computers plus my understanding of logic circuits remains pretty scant even now. I spent many hours reviewing every website I could find that might be of relevance to an early PET and would class these two sites as essential references:

1. For the original 2001 PETs ONLY Matthew D'Asaro's troubleshooting [page](#) is a superb guide in terms of fault diagnosis.
2. Bo Zimmerman's [site](#) is a fantastic resource for all PET owners. This is a [link](#) to the 2001 schematics section. Be aware that it's not always easy to find specific information on Zimmerman's site but time spent rummaging is time well spent.

FAULT FINDING

I should mention that I only used standard test equipment (DMM, Variac, oscilloscope etc). My initial aim was simply to try and get the machine working although ultimately the project did suffer a significant degree of project creep! Anyway I started off with the following:

1. At switch on a 555 timer circuit delays the application of the reset signal to the 6502 CPU. Without the delay the system doesn't stabilise before the processor activates, potentially causing the frozen garbage screen. Correct operation can be verified by monitoring the voltage on P40 of the CPU at power on. In my case the voltage rose from 0V to around 5V after a couple of seconds just as it should.
2. I spent some time partially lifting socketed ICs (30 of them) and applying contact cleaner before reseating each chip. This seemed worthwhile as elderly PETs are well known for developing poor pin connections over time. However this did not cure the fault.
3. By monitoring CPU data/address line activity and the clock signal using the 'scope I was able to gain some confidence that the CPU was not the root of the problem.
4. Faulty PIAs (2 of them in the PET) can cause the garbage screen fault but the PET should boot to the BASIC screen without them, albeit with no keyboard or interface functionality. In this instance removing the PIAs made no difference.
5. Two intermittent faults cropped up at this stage. The first was a horizontal black bar on the garbage screen and the second involved sudden loss of power. The intermittent power loss was cured by cleaning the contacts of the Molex power connector J8 and re-flowing the solder joints to the main board. The black bar disappeared, never to return, once I'd cleaned the contacts on the connections between the main board (J7) and the monitor itself.

Next I studied D'Asaro's troubleshooting guide in more depth which led me to the conclusion that either system RAM or ROMs were next on the list for investigation. If the problem didn't lie with RAMs or ROMs it would be necessary to fault find the remaining TTL chips.

D'Asaro's guide indicated that my machine's two video RAM chips (6550s) were working so I used the procedure described in the guide to identify any faulty system RAM chips. In the end I isolated six (out of sixteen) faulty 6550s which seems to confirm the commonly held view regarding the unreliability of the early MOS RAMs. I now had a working PET which booted to the BASIC screen albeit missing 3K of RAM.

Out of interest four of the faulty chips resulted in the garbage display. The other two allowed the system to boot but with reduced RAM and some character corruption.

REPLACING FAULTY RAM

Although I would have liked to replace the faulty chips with 6550s in order to maintain originality I could only find NOS replacements on offer at £15 a piece. To me spending £90 on potentially unreliable chips didn't look like a sensible investment so I opted for [this](#) alternative from NivagSwedna's Emporium. The board plugs into two of the RAM sockets and returned the PET to its original 2001-8 status. The original chips are packed away inside the case.

FAULTY PIA1 & PIA2 - SUB-PLOT

After numerous failed attempts to find the missing datassette I bought a battered replacement for a reasonable price. This had significant cosmetic damage as well as being electronically faulty. Its refurbishment would best be detailed separately but I mention it here because during testing of the datassette the PET frustratingly reverted to displaying the garbage screen and I subsequently found that programmes wouldn't load successfully from tape.

Eventually it transpired that there were issues with both PIAs. This was confirmed by substitution. PIA2 caused the reappearance of the garbage screen and PIA1 was the culprit when it came to loading programmes. It is possible that I caused PIA2 to fail by carelessly unplugging the datasette with the PET still powered on which should act as a warning to others not to commit the sin of hot plugging. On the other hand the problem with PIA1 was probably there all along.

Original 6522 PIAs are a bit thin on the ground but there are quite a few more modern equivalents to choose from. I successfully tried the Western Design Centre W65C21 and the Motorola MC6821.

ROM/RAM EMULATOR

I started thinking about buying an emulator quite early on in this saga especially as the unreliability of early MOS memory chips became more apparent. Along the way I decided to take the plunge. There isn't much commercially available choice in terms of ROM/RAM emulators for the PET but I settled on [this](#) partly because I was pleased with the same seller's 8K RAM board. These are some of the benefits of the product:

1. The emulator makes fault finding easier with a choice of two diagnostic tools (there's an NOP option as well).
2. The PET can now be set to run with 32k of RAM like some of its later brethren.
3. ROM functions can be taken over by the emulator in the event of 6540 ROM failure.
4. The emulator offers the opportunity to run with one of four versions of BASIC.
5. The PET is now reasonably well future proofed without having lost much, if any, of its originality.

I know there are those who would have built their own emulator (8K board as well) but I had neither the inclination nor the knowledge base to pursue that route.

As it happens the emulator's diagnostic tools pointed me in the direction of the faulty PIA2 although that particular problem could have been identified without the need for the emulator.

COSMETICS

The PET really only needed a thorough clean but the unsightly scratches on the top of the monitor needed attention so paint stripper was used on the top only. After careful masking I then resprayed the monitor's top and sides using white radiator enamel. This provided a reasonable colour match and I used primer which Commodore clearly didn't.

When cleaning I did pay special attention to the keyboard which was removed for the purpose. Each key was individually spruced up using nothing more than a damp cloth and I didn't attempt any dismantling.

Overall the PET is now in excellent cosmetic condition with very little evidence of significant use.

PARTS AND COSTS

The overall cost of the project came in at around £140 which included:

1. Initial purchase at a school bring & buy stall.

2. ROM/RAM emulator and 8K RAM board.
3. Replacement datassette, new drive belt and LM386.
4. Two PIAs, spare VIA and spare PIA
5. Consumables including paint.

When I started out I had no intention of spending so much and it could rightly be argued that the emulator, datassette and spare interfaces were unnecessary purchases in terms of getting the PET working to specification. Without these luxuries the total cost would have been more like £40.

Spare chips and the original faulty items are all neatly stored and labelled inside the PET's case together with the RAM ICs previously mentioned.

ATTACHMENTS

I've attached a PDF copy of the relevant schematic for reference and a file with a dozen photographs taken during the course of the refurbishment. There's also a PDF copy of this post which can be saved if required.

SUMMARY

Anyone reviewing the original thread will notice that the project meandered along over a period of three months. This was largely a reflection of my inexperience with micro computing which resulted in a few blind alleys and red herrings. However with the help and encouragement of fellow forum members I got there in the end.

I'm hoping this synopsis will provide some assistance and guidance to any future Commodore PET 2001-8 repairers/restorers. Any questions please ask and I'll do my best to answer.