

PIA Upgrade by Charles Hughes

Copyright 1990

So, you're a hacker are you? Well, then this upgrade is for you. If you aren't a hacker, well, have a try at it anyway.

A special NOTE - this upgrade can be done on ANY atari 8-bit computer, but these instructions only cover the 800 XL and 130XE machines.

Performing this upgrade gives you a second PIA chip in your computer.

You are probably wondering just what a second PIA chip can do for you, the answer is - anything you could do with the first, only better. Some possible uses are listed at the end of this text file.

Here are some standard precautions:

- 1) Opening your machine voids any warranty you may have.
- 2) CMOS chips hate static...ground yourself before working on your computer.
- 3) The author of this text is not responsible for what you do to your computer. If you aren't proficient at soldering, don't know a socket from an IC, or feel you are a total incompetent when it comes to the inside of your computer, then DON'T TOUCH!

Parts needed:

*1 65C21 (PIA chip)

1 74F139 (Dual 2:4 decoder)

1 74F138 (3:8 decoder)

1 16 pin IC socket

1 small perfboard about 2"x3"

Wire (lots of it, Radio Shack #278-372 - 24 gauge, 4 conductor telephone wire works great)

Phillips screwdriver

Pair of needlenose pliers

Rosin Core solder

Soldering Iron (25 to 30 watt)

Desoldering Iron (or Solder Sucker, but do not use solder braid)

IC Puller, etc

Several small cups for holding screws

Most XE computers will also need:

1 16 pin IC socket

1 40 pin IC socket

* There are several versions of the PIA chip any of the following will

work: 6520, 65C20, 65C21, 6820, 6821, and of course C014795 (Atari's chip #).

What to do:

- 1) Completely disconnect all cords, cartridges, and other items not permanently attached to your computer. Lay them to the side so that they can be reattached when you are finished.
- 2) Find a place in your house to do the actual work - it should be well lighted, have a power outlet nearby, and safe from accidents (like little kids interested in the pretty parts of your computer :). Sit down, put your computer on the table (bench, workspace, whatever) and continue with #3.
- 3) Turn your computer over. Remove the phillips head screws that are holding the bottom cover on. Place the screws in a cup, don't lose the screws, they are a pain to try to replace.
- 4) Ok, here is the first fun part -

A) Turn your computer back over and gently lift the top off. Place the top somewhere safe. NOTE: on the XL series the keyboard may be attached to the top, just pull the keyboard cable free of the motherboard as indicated in B.

B) Take the keyboard and slowly lift up, you will find that it is attached by a ribbon cable - pull this cable free of the main board and then place the keyboard with the top.

C) Locate the screws spaced around the motherboard that hold it onto the bottom. Remove these screws and put them in a second cup. NOTE: Some machines aren't attached with screws, you can just lift the motherboard free of the bottom case.

D) Pull the motherboard free of the bottom case. This is a little difficult, but if you do it slowly and carefully you won't hurt anything. Put the bottom cover to one side.

E) Remove the metal shields.

I. On some models the metal shields are attached by screws, remove these to remove the shields.

II. On other models the shields are held on by little metal tabs. Using the pliers, twist the little metal tabs so that you release the top metal shield.

F) Remove the top and bottom metal shields and place them to the side.

G) Place the motherboard, chip side up, in front of you. Go onto step 5.

5) Okay, you now have the motherboard sitting in front of you.

A) Position the motherboard so that the joystick ports are to your right.

B) Look at the 40 pin IC's and locate the one that has "6520" and/or "C014795" printed on it somewhere. This is the PIA chip already installed in your computer. In the 130XE this is near the joystick ports, in the 800XL this is the right most chip nearest you.

C) Look around the board for a small 16 pin IC with "74LS138" printed on it. This IC enables the PIA when it is accessed by the CPU. On the 130XE this IC is just below the PIA, on the 800XL this chip is the second IC down from the cartridge port.

D) Remember where these are...we'll be coming back to them. Now continue on with #6.

6) Okay, now an easy/hard part depending on the machine you have.

A) Remove the PIA from the motherboard. If the PIA is socketed this is easy - just use a small screwdriver to pry up each end a little at a time until you manage to free the entire chip. If the PIA is soldered in, pull out the desoldering iron and desolder it. Solder in a 40 pin socket I needed.

B) Remove the 74LS138 chip same as you removed the PIA. Solder in a 16 pin socket if necessary. Place the 74F138 in the socket. Put the 74LS138 in a safe place, you might be able to use it for some project in the future but you won't need it for this one.

7) Now we add the new PIA.

A) Take the new PIA (called PIA1 from now on) and bend pins 16 and 23 up so that they stick straight out from the sides of the chip. NOTE: If you have a memory upgrade that uses other pins on the old PIA you can bend up the same ones on the PIA1 and reattach the wires there.

B) Now take the PIA you just removed (called PIA2 from now on) and bend pins 2-19, 23, and 37-40 straight out the same way.

C) Place PIA2 on top of PIA1 so that all the pins not bent up on PIA2 touch the same pins on PIA1.

D) Solder pins 1, 20-22, and 24-36 of PIA2 to the same pins on PIA1.

E) Put this set of chips to the side for now and continue with 8 below.

8) Now we have to create the minor circuit needed for the upgrade.

A) Take the perf board you have, and put the 16 pin socket on it. The best place for it is in the upper left corner of the board. There is a notch in the black plastic of the chip, this indicates the placement of the IC chip. Holding the socket so that the notch is away from you, pin 1 is the first pin on the left hand side, pin 2 is the one below it, etc all the way to pin 8 the last pin on that side. On the right hand side, opposite pin 8 is pin 9, opposite pin 7 is pin 10, etc all the way to pin 16 which is opposite pin 1.

B) Cut 7 pieces of wire about 8 inches long and strip off about a $\frac{1}{4}$ inch of insulation on each end of all the wires.

C) Solder one end of each wire to pins 1-5, 8, and 16.

D) Now take the wire you soldered to pin 8 and solder the other end to pin 8 of the 74F138 you located earlier. If you prefer, you can solder wires that would attach to the 74F138 to the back of the motherboard. Just make sure you solder them to the correct pins of the '138 socket.

E) Solder the wire from pin 16 to pin 16 of the 74F138.

F) Solder the wire from pin 1 to pin 12 of the 74F138.

G) Solder the wire from pin 4 to pin 23 of PIA1.

H) Solder the wire from pin 5 to pin 23 of PIA2.

I) Insert the stacked PIAs into the PIA socket.

J) Take the 74F139 chip and place it in the 16 pin socket so that the notch in the chip is pointing in the same direction as the notch in the socket.

10) You now have two wires left unconnected. These two wires need to be connected to address lines A2 and A3. You can connect these wires to A2 & A3 anywhere you like, but the easiest place to solder these wires is to the ANTIC chip. Find the chip labeled "C021697". This is ANTIC.

A) Solder the wire that comes from pin 2 of the 16 pin socket to pin 11 of the ANTIC chip (address line A2).

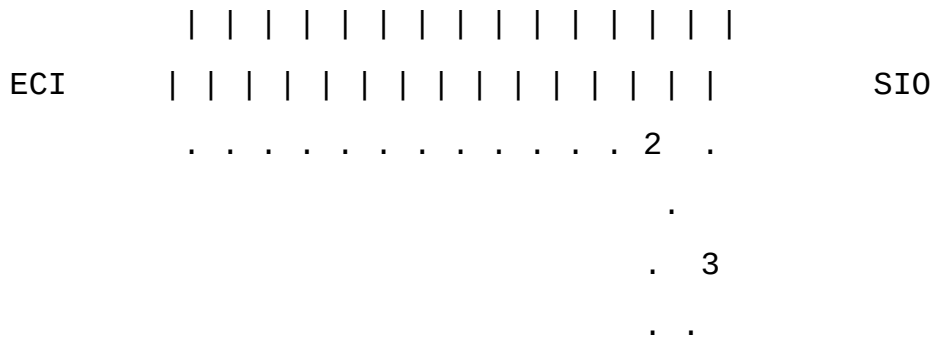
B) Solder the wire that comes from pin 3 of the 16 pin socket to pin 10 of the ANTIC chip (address line A3).

Another place to get these lines is from the parallel bus.

On the 800XL in the upper left hand corner are a pair of IC

chips. The top chip is BASIC, the chip beneath it is the OS ROM. To the right of the OS ROM is a line of solder points. The first point is A2, the second is A3.

If you have a 130XE look at the cartridge port, it should look like this:



This is a really rough drawing, the | indicate pins on the cartridge port, the . are solder points, the 2 is the solder point for A2, and the 3 is the solder point for A3. Just melt the solder at these points and stick the appropriate wire into the solder while it is still molten. ECI is the small connector to the right of the cartridge slot, SIO is the 13 pin sio connector to the left of the cartridge slot. 1200XL, 600XL, 65XE, and XEGS owners are on their own, I do not have any of these machines available to find suitable solder points on. I believe that the 600XL is identical to the 800XL as far as the parallel bus is concerned so you may be able to find the solder points in the same place. Remember however, that the soldering to the ANTIC chip will work regardless of the machine.

- 11) You need to put the perfboard in a safe place. If it is just hanging in midair let it keep hanging for now, but don't let any of the pins touch anything else.
- 12) Check all your connections and make sure you have followed all the steps above.
- 13) You have now finished all the necessary wiring. Now you have to test the finished product. Don't bother putting it all back together yet, just grab the bottom case of the computer and lay the motherboard in it. Plug in a basic cartridge (if you don't have any memory upgrades you don't need to use a basic cartridge). Connect the video connector. Connect the power cord. Turn on the computer. If you don't get a "READY" prompt and a blue screen, turn off the computer immediately and recheck all your work.

14) If you do get a "READY" prompt & blue screen, type in the following program:

```
10 P1=54016:P2=54020
20 ?PEEK(P1),PEEK(P1+1),PEEK(P2),PEEK(P2+1)
30 GOTO 20
```

15) Run the program. The first 2 numbers shouldn't change, the next two numbers may change and WON'T be exactly the same as the first two. If you stick a joystick in port 0 or 1 you can vary the second number. If the numbers are all the same, or all of them keep changing, turn off the computer, remove the power cord and recheck all your connections.

16) That's all there is to it, now reassemble your computer in reverse order of the way you disassembled it. :) Of course, you'll need to do something with the perfboard. Cover the pins of the 16 pin socket with an insulator (electricians tape or pieces of antistatic foam work well for this), turn the board over slowly and push it face down in an open space on the motherboard. You should then be able to put the metal shield back on.

If you can't, don't worry about it unless you get TV interference. If you get TV interference, move the computer farther from the TV.

Okay, now to wrap this text file up. You now have a second PIA chip located at addresses 54020-54023 (\$D304-\$D307). Here is the pinout of a 6520 (6521, 6821, 65C21, 6821B, etc):

Pin	Function	
1	GND	This connects to the system ground.
2-9	PA0-PA7	These are the port A pins.
10-17	PB0-PB7	These are the port B pins.
18	CB1	This is control line 1 of port B.
19	CB2	This is control line 2 of port B.
20	POWER	This connects to the system power (+5 volts).
	—	
21	R/W	This is the system read/write line. The line above the write indicates that writes occur when the line goes low (0 volts).
22	CS0	Chip select 0.
23	CS2	Chip select 2. This is an inverted signal - the chip is selected whenever CS2 goes low.
24	CS1	Chip select 1.
25	E	This is the system clock line.
26-33	D0-D7	These are the system data lines D0-D7.
34	RESET	When this line is pulled low the chip performs a reset.
This reset forces all pins to input.		
35-36	A0-A1	These are address lines A0 & A1 from the system bus.
37	IRQA	Port A IRQ.
38	IRQB	Port B IRQ.
39	CA2	This is control line 2 of port A.
40	CA1	This is control line 1 of port B.

And here is a short memory map of the new PIA.

PIA2: 6520 CHIP

54020 \$D304 PORT2A

(R/W) Controls the port A pins on the second PIA. Writes to direction control if bit 2 of PACTL2 is zero.

This port should be used for memory upgrades. To access any bank of extended memory using this port the extra lines needed for the memory should be attached in order starting at pin 2. A routine to access the extended memory is given below:

BASIC:

```
X =INT(BANK_NUMBER/4)
P2=BANK_NUMBER-X*4
Q =PEEK(54017)
Y =Q-INT(Q/4)*4
Z =INT(Q/32)*32
P1=Z+32+X*4+Y
POKE 54020,P2:POKE 54017,P1
```

ASSEMBLY LANGUAGE:

```
LDA BANK      ; Load the bank number
TAX           ; Save it for future use
LSR          ; Divide by 4
LSR
TAY          ; Save the upper bank control number
TXA          ; Reload the original bank number
AND #00000011 ; Mask out the rest of the bank number
ASL          ; Multiply by 4 to get into position
ASL
```

```

STA TEMP      ; Save again
LDA PORTB1    ; ($D301, 54017) Load the normal bank control
AND #%11100011 ; Zero out the old bank control bits
CLC
ADC TEMP      ; Add the new bank control bits in.
STA PORTB1    ; Select extended RAM and lowest 2 bits of the bank
number.
TYA           ; Get the upper 6 bits
STA PORTA2    ; Store the upper 6 bits of the bank number.

; 8 bits worth of banks is 256 banks or 4 Megabytes.

```

54021 \$D305 PORT2B

(R/W) Controls the port B pins on the second PIA. Writes to direction control if bit 2 of PACTL2 is zero.

This port should be used as a parallel port. The most likely use would be a centronics printer port.

54022 \$D306 PACTL2

(R/W) This is the PORT2A controller. Check out "MAPPING THE ATARI" or a datasheet on the 6520 PIA for more information on this.

54023 \$D307 PBCTL2

(R/W) This is the PORT2A controller. Check out "MAPPING THE ATARI" or a datasheet on the 6520 PIA for more information on this.

Here are some questions that will probably be asked about this upgrade and, of course, the answers to them.

Q: Why use 2 address lines to select only 2 PIA's?

A: Several reasons - the specific chip used (74F139) is a DUAL 2:4 decoder. This means using 2 address lines it can select 4 PIA's. If you decide you want another PIA just solder it on top of the others, run a wire from pin 4 of the 16 pin socket to the pin 23 of the PIA and you have a third PIA. A fourth PIA works the same except the wire comes from pin 5 of the 16 pin socket. Also, most memory upgrades use a 74LS138 or 74LS139.

Since we only use 1 of the 2 2:4 decoders in the 74F139, and all the memory upgrades (except my monster 4MEG one :) use the equivalent of 1 2:4 decoder, we can remove the other chip and rewire the memory upgrade slightly so that it uses our 74F139.

Q: Why use a perfboard, why not just put the 74F139 on the motherboard someplace?

A: Easy question. The reason for this is so that you can add other circuits to the perfboard and not lose access to any of the chips on the motherboard. The perfboard has enough space to hold the IC's needed for any upgrade and that is what I use it for in my computer.

Q: Why did you replace the 74LS138 on the motherboard with a 74F138?

A: Because the 74LS138 was too SLOW. My first attempt at this upgrade frustrated me so much that I quit for a few weeks in order to avoid attacking my computer with a sledgehammer.

More questions will be added as I receive them (or think them up myself :).

Future projects for this upgrade:

1. Restore the 2 missing joystick ports.

This isn't difficult, but currently no software except that which you write yourself would work. As soon as I get the time I will explain exactly how to add 2 joystick ports that are almost identical to the ones that the 400/800 had.

2. Add additional internal ROMS - multiple OS's, BASIC & ASSEMBLER, etc.

The XEGS machine has BASIC and STAR RAIDERS built into it. There are several ways this could have been done, the most likely way is through the use of bit 6 of port B of PIA1. Port B controls bank selection and bit 6 is the only bit that was unused in the 130XE so it is the most likely candidate for controlling whether BASIC or STAR RAIDERS is accessed. There is no reason you can't have BASIC and STAR RAIDERS built in too, nor is there any reason you couldn't have any cartridge built in.

3. Really get sick and control up to 8 megs of internal memory.

This is my main reason for adding the second PIA. I bought 144 256K dram chips real cheap, so I wanted to make a HUGE upgrade. I haven't done it yet, but I probably will add 2 MEGs right onboard my computer. (There is a use for this, see below.)

4. Run several "virtual" machines.

Tom Hunt of MTOS fame created a wonderful program called SNAPSHOT. What it does is take a 'snapshot' of what your computer looks like and stores it in extended ram - i.e. 16K rambanks found on upgraded machines and 130XE's.

Each snapshot takes up 64K (4 banks). You can then switch snapshots by pressing a few keys. You could have Textpro running, activate the snapshot program, and then be in Bobterm. The snapshot program creates a virtual machine that it swaps in and out of main ram when snapshot is activated.

With his help I plan on creating a special upgrade that does in hardware what he is doing in software. So, when snapshot is called,

instead of the program actually copying the main ram to the extend ram it will just swap ram in 64K chunks. This will speed up the snapshot process and make it considerably more useful.

5. Add a centronics parallel printer interface.

This is easier than it might sound at first. The PIA is made for exactly this type of work. A few wires, a centronics connector, and some software and you have a standard printer port.

6. Add an RS232 port.

This is an extensive project, not hard but not anywhere near as simple as just adding the PIA. However, it would cost a lot less than an 850 interface, and would work better than it too.

7. Get rid of all the nasty switches you have stuck in various places on your computer! (Except for the cold start switch of course. :)

Certain upgrades require switches in order to enable/disable banks of ram so that the switchable BASIC, ANTIC, SELFTEST, and OS can be used.

This is silly, just rewire the upgrade so that it uses port A of PIA2 and you have all the extra memory you need accessible all the time. There is a catch of course, there is no software that recognizes this second PIA, YET!

I'll have an RD.COM file for SPARTA ready soon, and a fix file for MYDOS when I get the chance. SpartaDos X is a whole other ball of wax...I can modify the ramdisk driver I think, but since the SDX cart looks for the total memory available when it first boots I don't think I can write a patch for it. ICD has promised to do so if this upgrade is popular enough.

So let's make it popular, ok? :)

Those are just a few that I could think of off the top of my head, I am sure others will occur to me and, hopefully, to you.

If you have any questions or comments I can be reached at:

CLOSER TO HOME BBS (419) 368-4413

ATARI BASE BBS (408) 745-5306

BAAUG BBS (408) 986-0215

Usenet: Ordania-DM@cup.portal.com

or Charles_Hughes@cup.portal.com

Or USnail:

Charles Hughes

555 E. Washington Ave. #301

Sunnyvale, CA 94086

Phone: (408) 732-7749