

## Notice Regarding this Upgrade

### Warning!

Although this upgrade has been tested and the techniques used will not directly cause harm to your Star Wars arcade game, if you do something wrong, you can very seriously damage the game electronics!

To perform this upgrade you should:

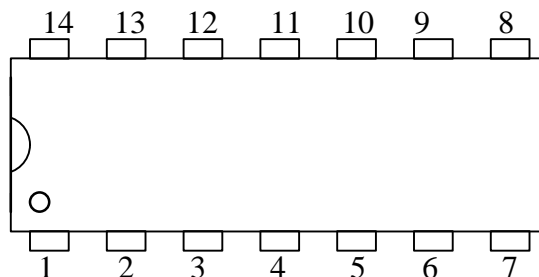
- Have a working understanding of electronics.
- Be familiar with safe handling procedures for electronic components.
- Have basic soldering and electronic assembly skills.
- Be able to follow directions.

Arcade games are rugged equipment, but anytime you start messing around with something (particularly something electronic) you accept a certain amount of risk that you may break something.

This kit carries with it no guaranty of compatibility to your particular game. Although all Star Wars PCB's (Printed Circuit Boards) are believed to be of the same layout and electrical characteristics there's a remote possibility that some of them are different. If you carefully follow these instructions, you'll do fine and everything will work. If this looks like it's above your confidence level please recruit someone locally to install the kit for you!

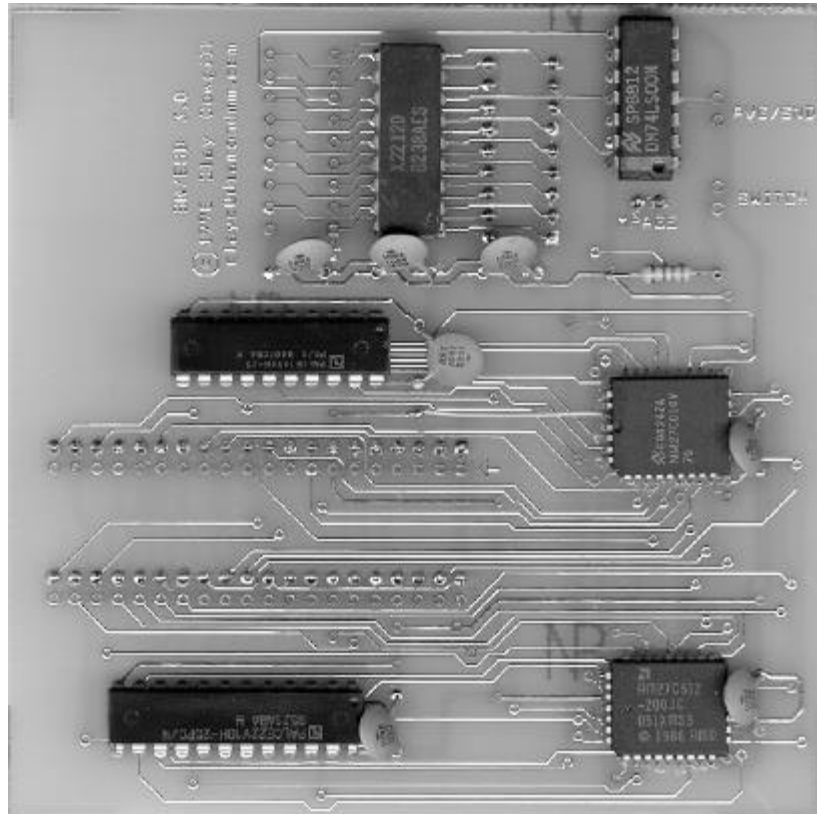
Please read these instructions completely through before starting. If at any point your PCB looks significantly different than what you see in here, please ask before trying something!

Since this is as good of place as any, this is how IC's are numbered (you start at the notch or dot and work you way around counter-clockwise):



## Introduction:

The Empire Strikes Back kit is a printed circuit board and collection of chips that with some wire, a switch, and some time and a little soldering will allow you to convert your Star Wars arcade game board into a “switchable” Star Wars/Empire Strikes Back Game.



These instructions describe how to install the ESB 3.0/3.1 Daughtercard PCB into a Star Wars boardset with only requiring one cut on the Star Wars PCB (or an IC).

So before we get started, grab your favorite beverage, maybe something to snack on, and find a quiet place to read this manual so you fully understand what to do before you start tinkering around with your precious Star Wars boards!

## Getting Started:

First, let's cover what you'll need in some detail. We'll start with the base ESB Kit which includes the following:

- ESB 3.1 Printed Circuit Board (1)

The “Mathbox” PROMs (82S137's):

- PROM “7H” (Atari part number 136031-110, PROM\_7H.BIN)
- PROM “7J” (Atari part number 136031-109, PROM\_7J.BIN)
- PROM “7K” (Atari part number 136031-108, PROM\_7K.BIN)
- PROM “7L” (Atari part number 136031-107, PROM\_7L.BIN)

A set of EPROMs programmed with both the Star Wars and Empire Strikes Back game code. There are 2 27C256 type EPROMs and 1 27C64 type (28 pin DIP packages):

- EPROM “SND 1H” (SND\_1H.BIN)
- EPROM “SND 1J/K” (SND\_1JK.BIN)
- EPROM “AVG 1L” (AVG\_1L.BIN) (this is the 27C64 EPROM)

In addition, you'll also want to have the following handy:

- Wire (30ga wire-wrap wire is fine for the PCB work)
- A soldering iron (15-30 watts with a small tip. The blue \$8 Radio Shack iron is great.)
- Wire cutters (Suitable to cut a leg on an IC as well as wire)
- Wire strippers
- Something to remove socketed chips (I like a small standard screwdriver—use what you're comfortable with.)
- A single-pole single throw switch (for switching between games)

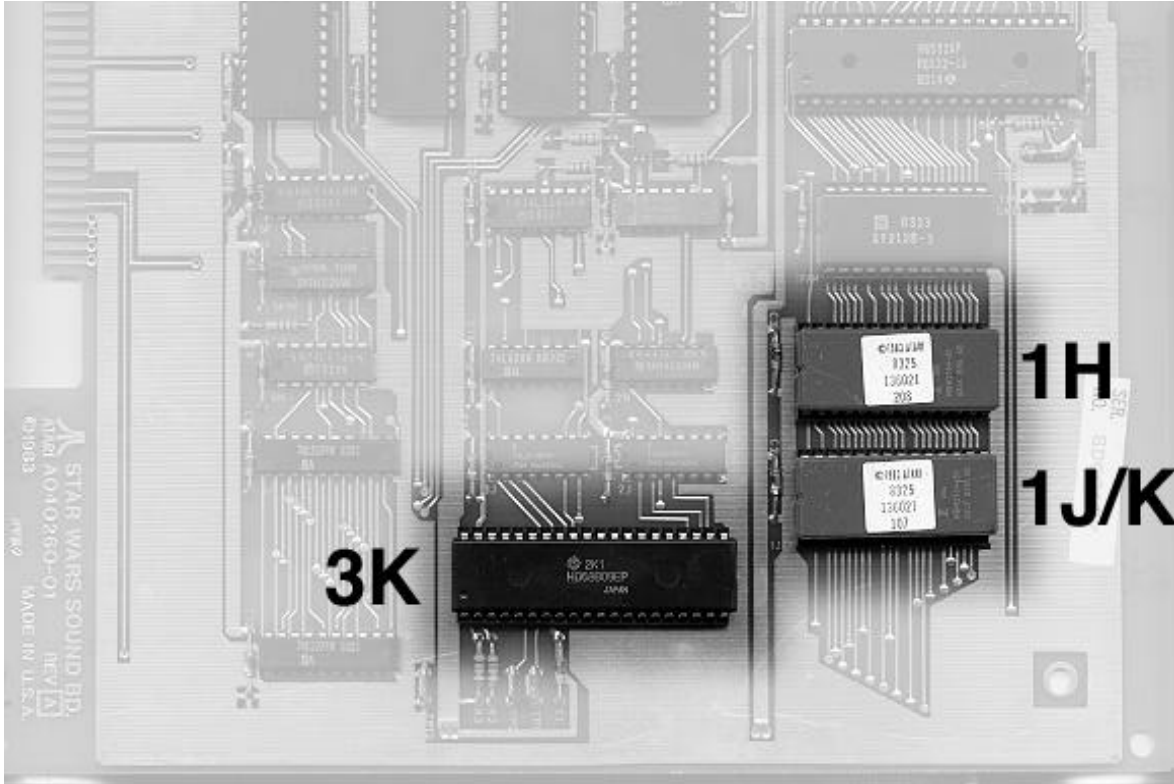
Gather your parts and tools and prepare a clean workspace that you can hack at for a while...

## Get to know your Star Wars boards:

Star Wars consists of three different Printed Circuit Boards (PCB's) connected by a small “interconnect” board. We'll start with a brief explanation of each board and show which parts you'll be working on.

## Sound board:

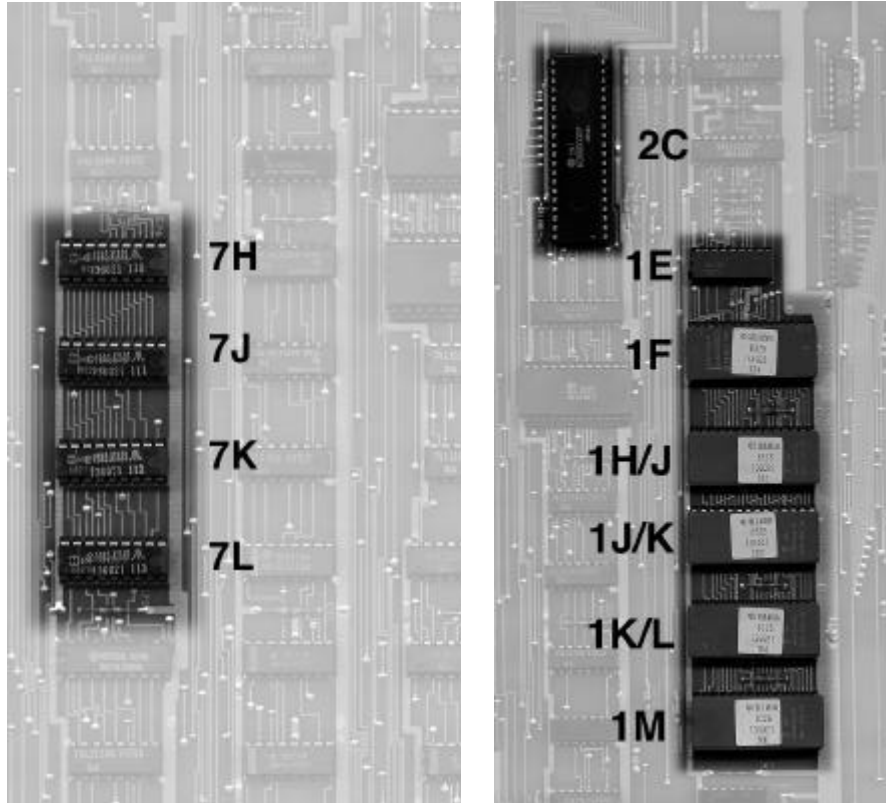
The sound board is usually the first PCB in the stack of Star Wars boards. It's the smaller board with lots of "foil" on the top. You'll note that it's labeled "STAR WARS SOUND BD.". Holding the board so the larger edge connector is on the left, you'll see something like this:



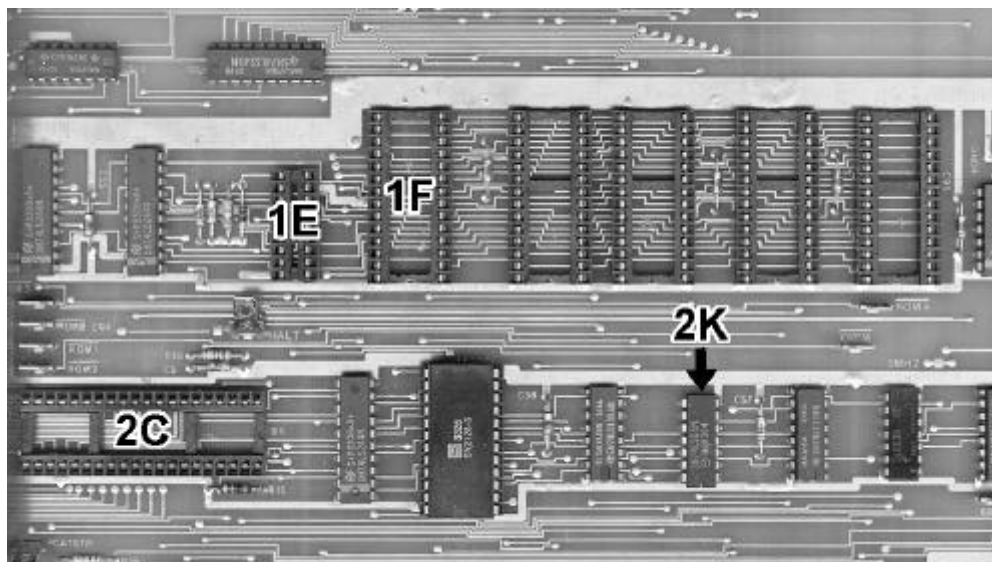
Later on you'll be soldering a wire to one of the pins of the 6809 at location "3K" and replacing the ROMs at locations "1H" and "1J/K".

## CPU board:

The CPU board is the brains of your Star Wars. This time hold the board so that the large edge connector is on your right. (The writing on the chips will be “right side up” this way.) On the right hand side of the board and in the center of the board you’ll see something like this:

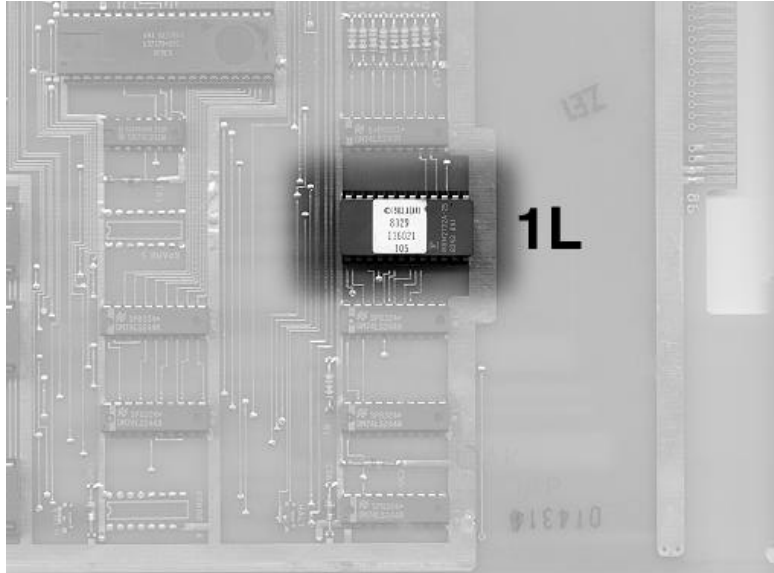


You’ll be replacing the PROMs (on the left, 7H-7L); removing the EPROMs (on the right, 1F-1M); removing the NOVRAM at 1E; removing the CPU at 2C; and placing the daughtercard in the socket at 1F, 1E and one pin at 1F.



## Analog Vector Generator Board:

The AVG is responsible for drawing all those snazzy vectors you see during the game. Holding the AVG so that the large edge connector is on your right you should see something like this in the lower right hand corner:

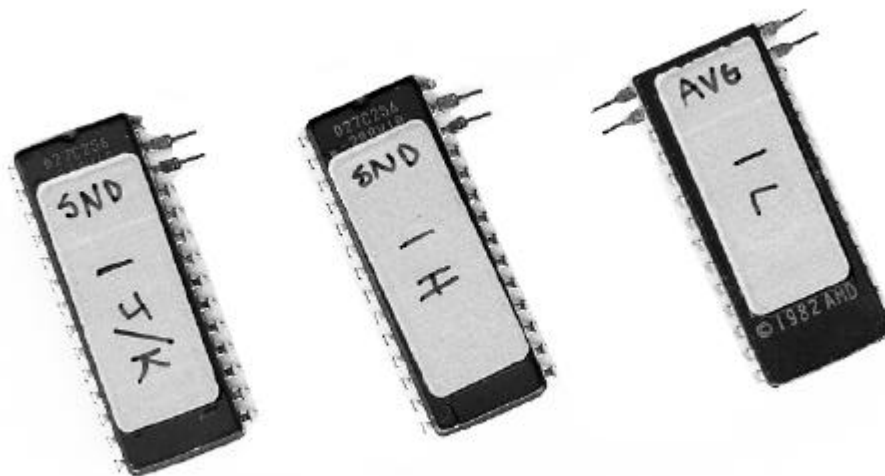


You'll be replacing the EPROM at location 1L with a larger EPROM to hold data for both Star Wars and Empire Strikes Back.

## Let's Get To Work:

Locate your "SND" EPROMs and the "AVG" EPROM. You will need to bend some pins "out" on the chips to allow attaching wire later on.

- On "SND 1 J/K" and "SND 1H" bend out pins 27 and 26.
- On "AVG 1L" bend out pins 1, 2, 27 and 28.



## Modify the Sound Board:

It's time to modify the sound board. We'll be soldering wires onto the bent-out "SND" EPROM pins and onto a pin on the 6809.

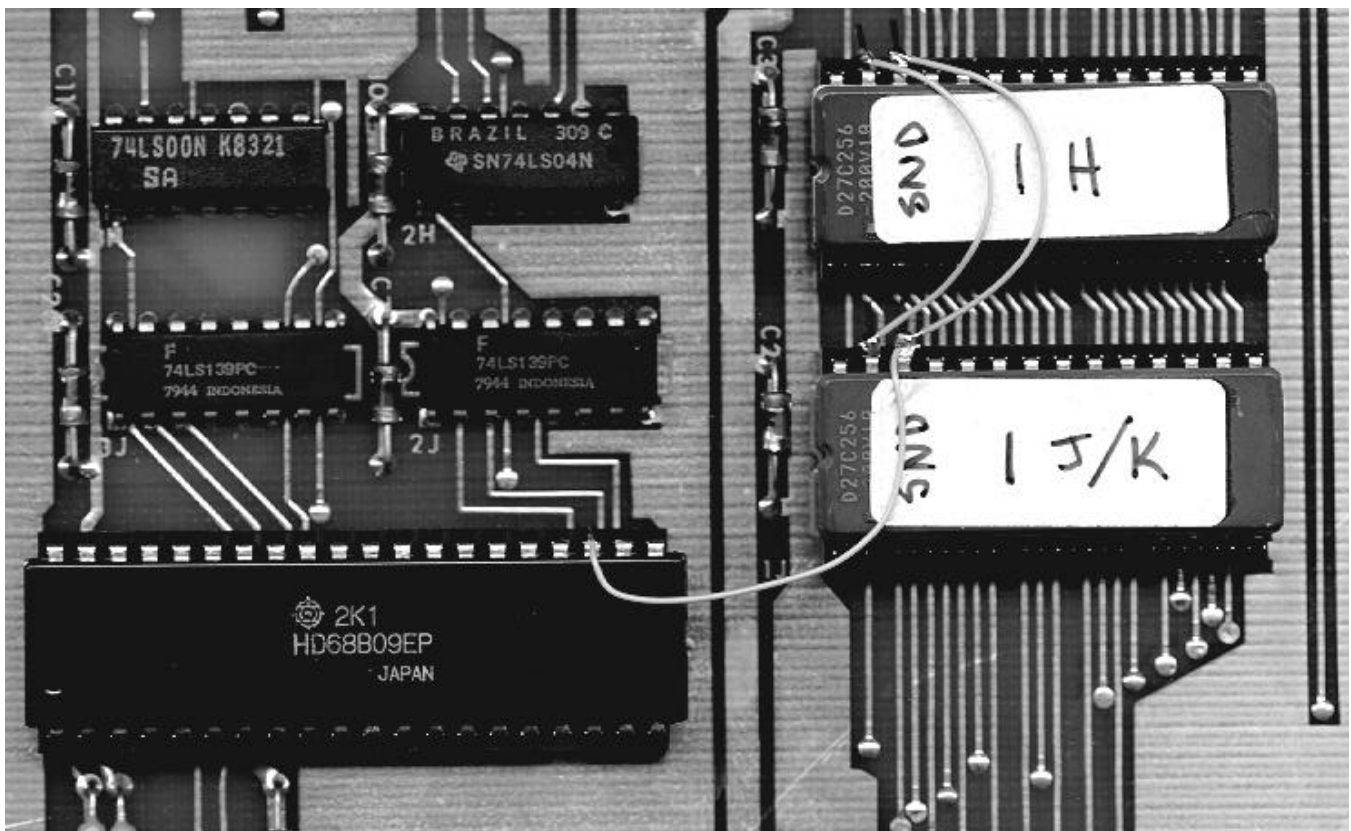
Remove the EPROMs at location "1H" and "1 J/K". Keep them—maybe you'll want to switch back or save another Star Wars someday. Install your replacement "1H" and "1 J/K" EPROMs (with pins 26 and 27 bent out) into the "1H" and "1 J/K" sockets, respectively.

Solder a wire from Pin 23 of the 6809 at position "3K" to Pin 26 of the EPROM at "1 J/K".

Solder a wire from Pin 26 of "1 J/K" to Pin 26 of "1H". (You just connected an extra address line to the EPROMs to allow for more sampled voice that Empire Strikes Back uses.)

Solder a wire from Pin 27 of "1 J/K" to Pin 27 of "1H". (Later on we'll be connecting pin 27 of these chips to the other replacement chips.)

Your finished Sound board should look roughly like this:



## Modify the AVG Board:

The AVG board modifications are easy, so let's get that one out of the way.

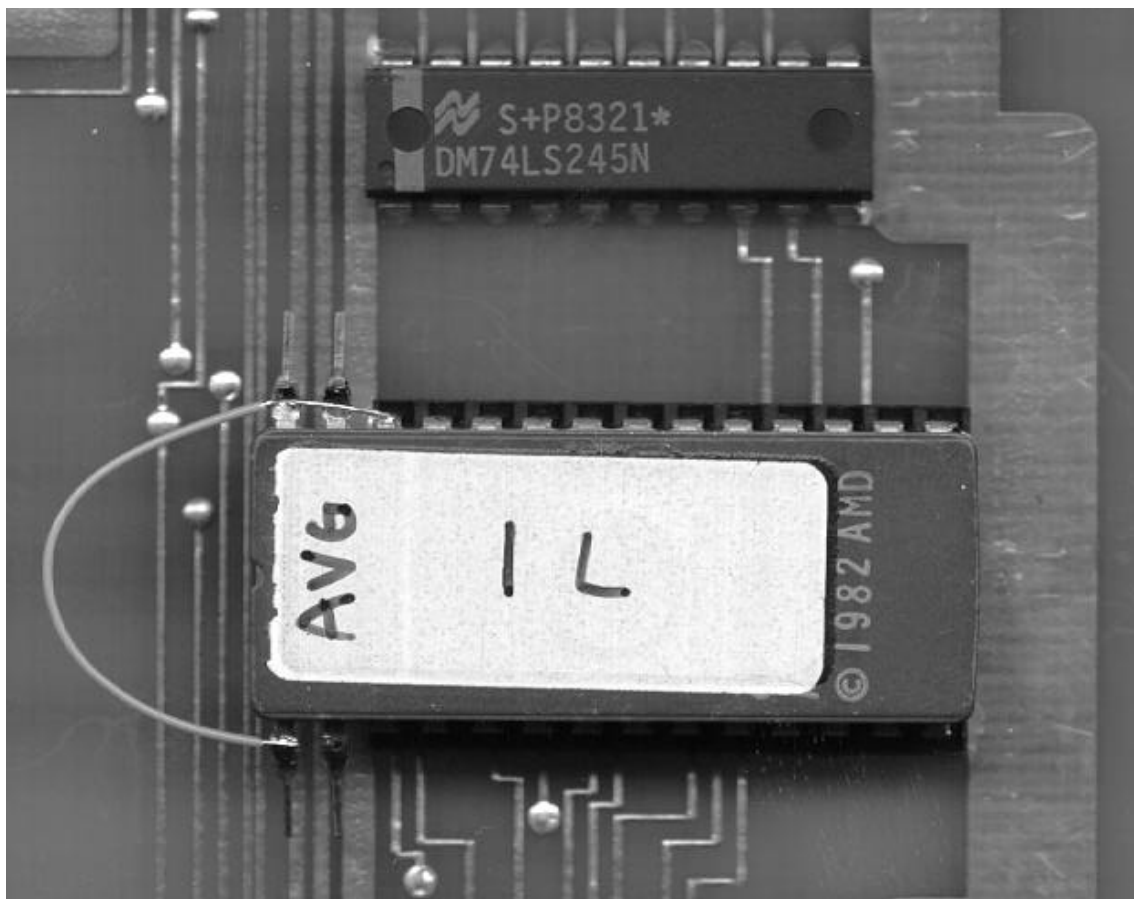
Remove the EPROM at location "1L". Keep it with the rest for a rainy day. ☺

Install your replacement "1L" EPROM. You'll notice that the socket is only 24 pins, but the chip is 28. (Hmmm...) Place it in the socket so that the four pins that you bent out earlier are hanging off the edge closest to the big chips on the left side of the board.

Solder a wire to Pin 26 of the EPROM (it's the last pin that's IN the socket on the top-left of the picture below) and connect the same wire to Pin 27, Pin 28, and Pin 1 of the chip. (Pins 27,28, and 1 are all hanging off the end of the socket out in thin air...) You've just connected the +5V power supply line from pin 26 (pin 24 of the 24 pin socket) out to the replacement chip. Good job.

Pin 2 will be left disconnected for now, but we'll be connecting the other replacement chips to it later.

You should have something looking like this now:



You can put the AVG board aside for now. We're basically done with it.



## CPU Board:

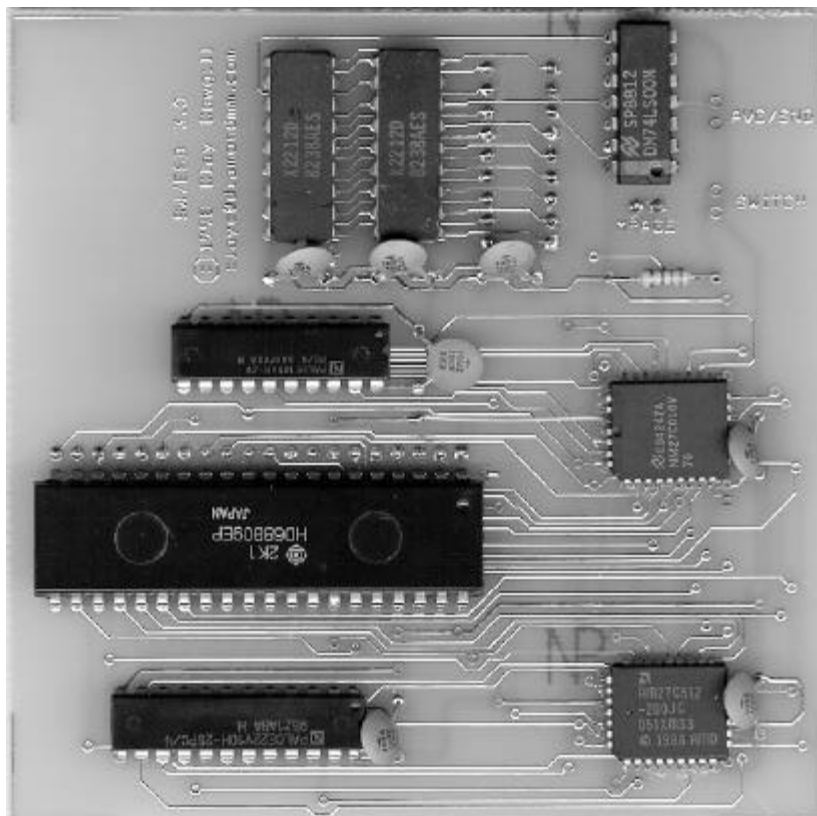
Time for the main board!

Remove the Star Wars EPROMs from locations “1F”, “1H/J”, “1J/K”, “1K/L” and “1M”. Stash them with the rest of your Star Wars EPROMs.

Remove the NOVRAM at 1E and place it in the Daughtercard next to the NOVRAM already on the PCB. The orientation will be the same as the NOVRAM next to it. There is a small arrow on the PCB pointing to pin 1. The chip will be a VERY tight fit into the holes on the PCB. Make sure the pins line up exactly! Gently press it into place making sure not to “fold” any pins under in the process. Solder it down once you’re certain no pins were bent and everything looks OK.

Remove the 6809 processor at location 2C. Place the processor in the empty 40-pin location on the daughtercard. Once again, a small arrow on the PCB marks where pin one should go. The chip will be a VERY tight fit into the holes on the PCB (this allows me to place a processor on the card without soldering it in place when I test each board before shipping). Gently press it into place making sure not to “fold” any pins under in the process. Solder it down once you’re certain no pins were bent and everything looks OK.

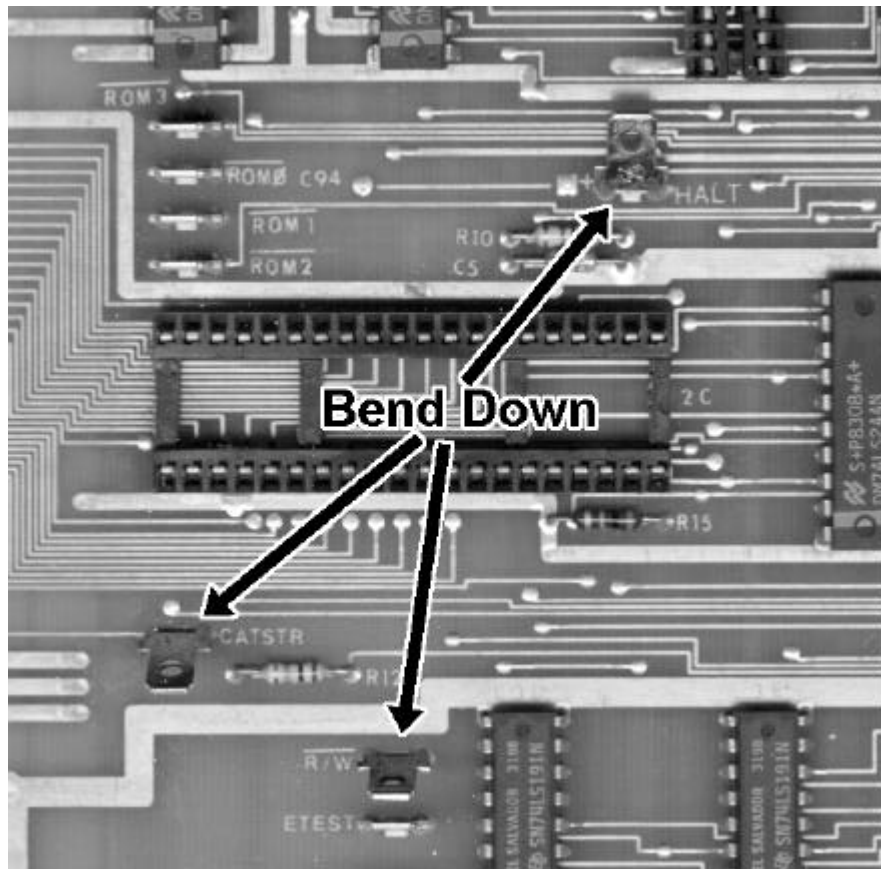
The daughtercard should now look something like this:



## Attach the Daughtercard:

Your daughtercard should be fully assembled and ready to go at this point.

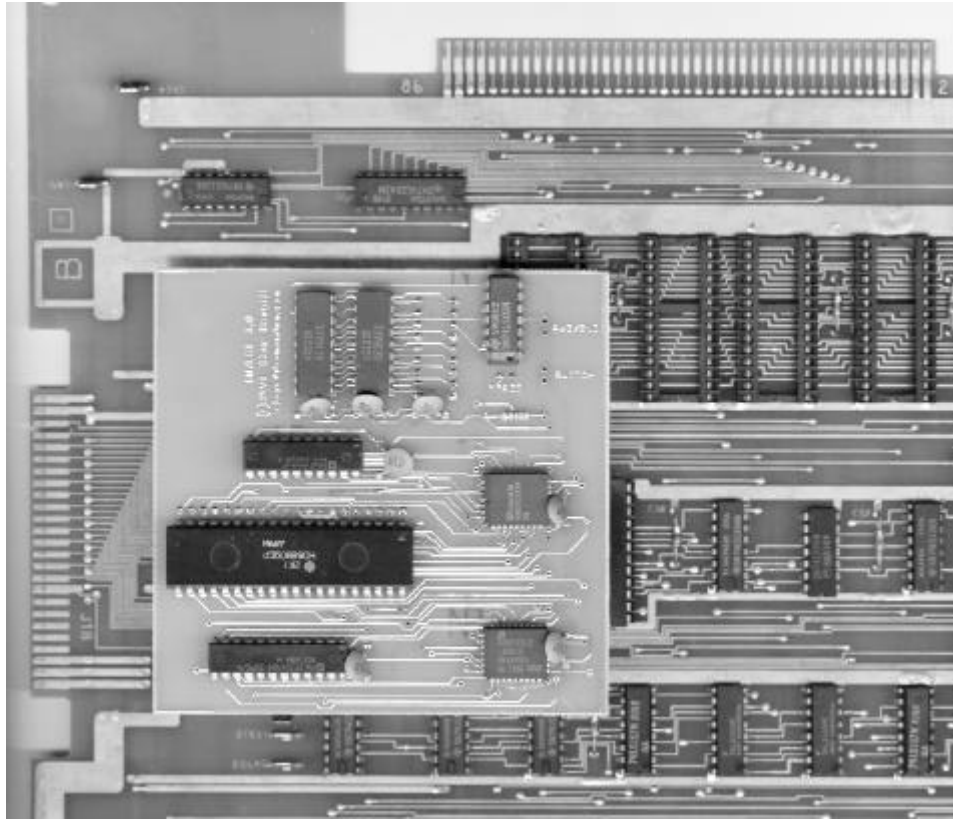
Around the CPU socket (2C) are a number of “test points”. (Little metal tabs with labels like “HALT”, “ROM1”, “VMEM”, “CATSTR”, etc.) You’ll need to bend a few of them down a bit to give the daughtercard some clearance. You want to bend “HALT”, “R/W”, and “CATSTR” over slightly. (Rev A CPU boards will not have “HALT” in the way of the daughtercard, so don’t worry if the picture is a little different.) You don’t need to bend the test points too far—just enough that the traces on the daughtercard won’t touch.



Take the daughtercard and orient it so that the pins on the back of the daughtercard line up with the sockets at 2C, 1E, and 1F. Firmly press the daughtercard into place. It should seat in the sockets completely and sit level.

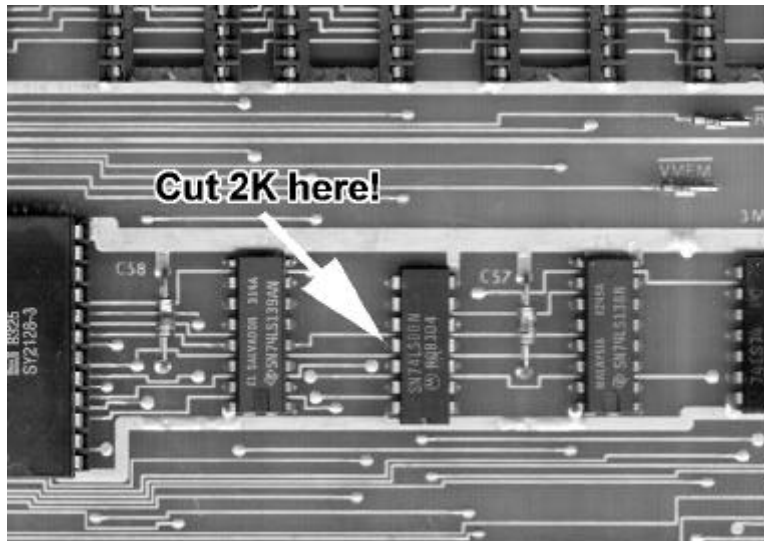
You should have something that looks like this:

(continued on next page)



## The Cut:

Locate chip 2K. It is a 74LS08. You will need to physically cut pin 11 so that it is no longer connected to the PCB. (Alternatively, you can cut the PCB trace on the board that goes to pin 11. Soldering a cut pin is a little easier to fix in my opinion so I just do that.) This lets the daughtercard “take over” the CPU board.



## Finishing up the CPU board:

Remove the Mathbox PROMs at locations “7H-7L” on the CPU board. Store these with your Star Wars EPROMs.

Replace the Mathbox PROMs with you new set. Each part goes into the socket of the same name—PROM “7H” goes into socket “7H”, PROM “7J” into socket “7J” etc. Be sure to keep the chips oriented the same way on the PCB! (There’s really not much to see here, so I’ll omit the picture.)

Hang on! We’re almost done! Just a small matter of a switch and a couple wires to hook up...

## Almost Done:

Decide where to place your game-switcher switch. You’ll need two more pieces of wire long enough to reach from the “back” of the card cage (closest to the coin door) to where-ever you’re putting your switch. It’s helpful if you have the wires as a “pair” (like thin speaker wire, although two separate pieces work fine too). I find that the solid-core “alarm” wire from Radio Shack works well. Solder one end of each lead to the “switch” holes on the daughtercard. When you slide the boardset back into the cardcage, you can just push the wire up through the air vents and run it wherever you want. Then solder the switch to the other ends of the wire and mount it however you like.

Take some wire and connect one end to pin 2 of the EPROM on the AVG board. Connect the other end to one of the holes on the daughtercard marked “AVG/SND”.

Take another piece of wire and connect it to pin 27 of the EPROMs on the sound board. Run the other end to the remaining hole marked “AVG/SND” on the daughtercard.

(Remember to consider how this whole thing is going to slide into the RFI cage (if you’re using one) and run your wires so as not to get in the way.)

Once the boards are wired up you can re-assemble them into the “backplane” connector that hooks them all together.

## Final Test:

If you’ve done everything right you should now have a working, switchable Star Wars/Empire Strikes Back game!

If possible, use an ohm meter to check the resistance between power and ground on the Star Wars/ESB boardset. If you read 0 ohms (or anything much under a hundred) you probably have a power short! Go check your work before trying anything!

When you first try the game, do **not** hook up the monitor! If something isn’t right the board set will often just “draw” a line at maximum deflection and hold it there—tends to pop fuses on the deflection board! Start the game in “test” (the switch behind the coin door) mode with everything connected but the monitor. You should hear a series of 16 high-pitched “beeps” in sequence. If you hear any “boops”

(low pitched beeps) you have an error of some sort—go double check your wiring and make sure all the EPROMs are socketed properly and there are no pins **unintentionally** bent out of the sockets. ☺

Unfortunately, Atari had some cheap sockets in some Star Wars games, and changing the EPROMs can result in pins breaking off internally to the socket and will give you ROM errors! There isn't much to do in this case except remove the sockets and replace them. This is not a job for the in-experienced! Get help if you haven't done it before...

If you have problems, listen to the “audio error codes” in self test mode and go by the following codes and tips:

A "beep" means the component tested OK. A "boop" means the component failed the test.

There are 16 beeps followed by a pause. After the pause the pattern repeats.

## Star Wars/Empire Strikes Back Audio Error Codes:

Beep #	Description
1	RAM 2F/H on the CPU board (a 2Kx8 for the CPU)
2	RAM 5F on the CPU board (a 2Kx8 for the Matrix processor)
3	RAM 5H on the CPU board (a 2Kx8 for the Matrix processor)
4	RAM 3L on the AVG board (a 2Kx8 for vector RAM) ***
5	RAM 3M on the AVG board (a 2Kx8 for vector RAM)
6	RAM 4P on the AVG board (a 2Kx8 for vector RAM)
7	RAM 4L on the AVG board (a 2Kx8 for vector RAM)
8	RAM 4M on the AVG board (a 2Kx8 for vector RAM)
9	RAM 4P on the AVG board (a 2Kx8 for vector RAM)
10	NOVRAM 1E on the CPU board (a 2212 Xicor 256x4 NOVRAM)
11	EPROM 1F or 1M on the CPU board +++
12	EPROM 1 J/K on the CPU board
13	EPROM 1 K/L on the CPU board
14	EPROM 1F or 1M on the CPU board +++
15	EPROM 1 H/J on the CPU board (The daughtercard for ESB)
16	EPROM 1 L on the AVG board ***

\*\*\* The video display will not work properly in test mode if either of these are corrupt.

+++ The self test won't run at all if either of these are too corrupted.

(The 2Kx8 RAMs are “2016’s” if you need to replace any. “6116’s” and “9128’s” should work too.)

## Other Troubleshooting Information:

- If either of the Sound ROMs are "dead" you will get no sound (or just grinding noises from insane POKEYs).

- If your Sound ROMs are swapped you'll get weird grinding noise as it tries to make "beep" and "boop" sounds.
- When switching games, some machines require that the power be turned off BEFORE you switch or else they won't save the high score and settings information to the NOVRAM. It seems to vary from machine to machine, so experiment on yours. (It's technically "safer" to switch with the power off anyway, since it's less likely to damage your monitor if the CPU doesn't reset properly. Your Mileage May Vary. If in doubt, turn the game off before switching.)

## **Conclusion:**

I hope this works out for you all—feel free to ask questions if you have problems. You shouldn't be able to damage anything by performing the upgrade if you're careful doing it.

There have been LOTS of people that have installed the kit without problems, so they definitely work. If you have problems and can't find the fix yourself, feel free to contact me.

Good luck, have fun, and of course... May the Force be with you! \*grin\*

-Clay  
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