Williams Multigame

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Notice Regarding this Upgrade

To perform this upgrade you should:

- Be familiar with safe handling procedures for electronic components.
- Be able to remove socketed IC's (chips) without causing damage.
- Understand IC (chip) pin numbering.
- Have some experience soldering with electronic components.
- Be willing/able to follow directions.
- Have a low-wattage (~15-20W) soldering iron. (The "blue" Radioshack iron is fine.)
- Have some fine solder (.31" diameter or so—Radioshack has this too.)
- Have access to miscellaneous tools—screwdrivers, wire cutters, etc.
- Have some minor supplies—hot glue gun and glue, tape, maybe some styrofoam…
- Have access to more complete supplies (wire, connectors, tools, wood, metal, etc.) if you're installing the JAMMA adapter and/or for customizing controls if you wish to run all games from a single control panel.
- Although not required, some steps go much easier with a Multi-meter or continuity tester.

Arcade games are rugged equipment, but anytime you start messing around with something (particularly something electronic that's 20 years old) 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 this kit has been tested with numerous Williams arcade games and CPU boards, there's a possibility that some of them are different. If you carefully follow these instructions, you should do fine and everything should work. I'll try to help walk you through any problems you have, but 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, contact clay@yahoo.com before continuing!

This upgrade should ONLY be used on a genuine Robotron or Joust game circuit board. Experienced users will be able to make it work with other modified CPU boards, but this will not be covered in the manual.

Introduction:

The Williams Multigame consists of a set of daughter cards (shown on the cover) that plug into your Williams Robtron/Joust boardset. An optional "JAMMA adapter" is also available for using a Robotron/Joust boardset with a JAMMA cabinet.

Once the Williams Multigame is installed in your boardset you will have an on-screen menu built into your game with which you can select up to any of up to six different games to play!

These instructions describe how to install the kit into a working Robotron/Joust arcade game and how to operate the Multigame. Some minor soldering is required (connecting power and ground to one of the daughtercards). All operations are fully reversible. Please read all these instructions thoroughly before starting the conversion. Working slowly and carefully a basic installation should take about an hour. After you've done one, the next would probably take ten minutes. Building a good control panel could take as long as you want!

Games Compatible with the Williams Multigame	Description
Robotron	Robotron (solid blue label) One heavily armed clone. Hundreds of killer robots. The rest is history.
Joust	Joust (solid red label) Using flying ostriches as mounts, two players joust against a common enemy (or each other!).
Stargate	Stargate (common version) Sequel to Defender with additional gameplay elements and features. Arguably the most complex set of controls on a classic game.
Bubbles	Bubbles (red label) Scrub a sink of dirt, bugs, and hazards. A non-violent departure for Williams.
Defender	Defender (red label) The game that put Williams on the video-game map and made Eugene Jarvis and the Vid Kidz idols of programmers for years to come. "Too hard to be successful."
Splat!	Splat (common version) A curious food-fighting game with giant, violent corn cobs, garbage monsters, and pie-wielding hitmen.
Williams Multigame Menu	Your one-stop shop for all of the above. About 5300 lines of hand-written assembly code. ☺

Notes:
1) The included MS-DOS software needs to have the same type of ROM images available as noted above. If you're reading the ROMs off your own boards it's possible they won't be the right revision to work with the multigame. In this case you'll need to download the correct version off the internet. As long as you have the original ROM boards (regardless of version) this is perfectly legal to do.
2) Game scores and settings are stored in the Non-volatile SRAM chip on the Multigame. The battery life of this chip is expected to be about 10 years. After that time, the chip will need to be replaced.
3) For maximum enjoyment it is highly recommended that a custom control panel be constructed to allow access to all the necessary game controls without needing to take the game apart to swap in other panels. Using the JAMMA adapter and placing a Williams boardset with the Multigame in a JAMMA cabinet actually works remarkably well.
4) At anytime, pressing Player 1 and Player 2 start will reset the Multigame.

The Kit:

The Williams Multigame kit consists of the following pieces:

- This manual
- The "preparing your EPROMs" manual
- The Williams Multigame boards
- A 24 pin dual-wipe IC socket
- The (optional) JAMMA adapter

Preparing the game boards:

Start with the machine turned off and unplugged from the wall. Open your game to gain access to the game circuit board. It is possible to install the Multigame without needing to remove all the circuit boards from inside the game cabinet. If you do elect to take anything out for easier access, **make *SURE* you mark or somehow identify where the cables need to re-connect to the board!**

The Williams system consists of four separate boards, typically mounted on two metal plates. These are the CPU board, the ROM board, the "Widget" (I/O) board, and the Sound board. Depending on the game you should have something that looks like this:

Williams CPU board, ROM board, and Widget board (shown in a Joust machine)
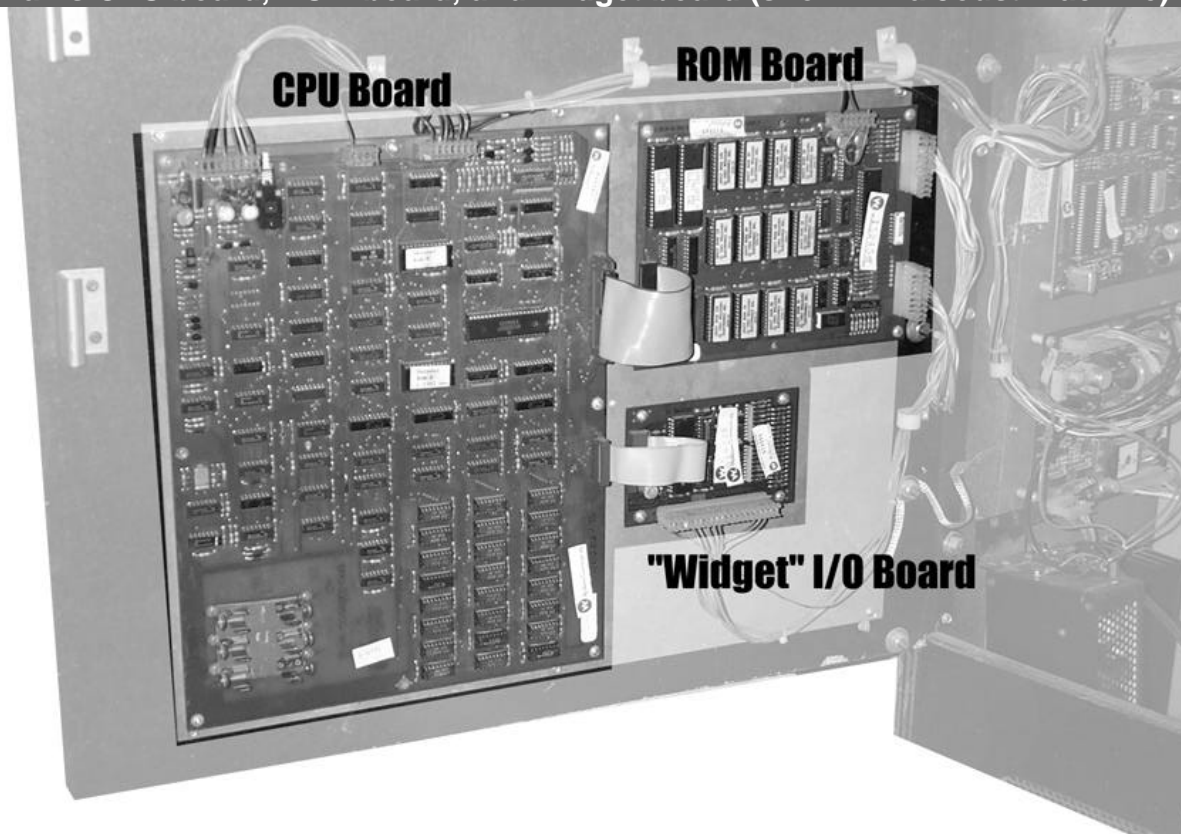
The Sound board is mounted on a smaller metal plate with the power supply.

Sound Board
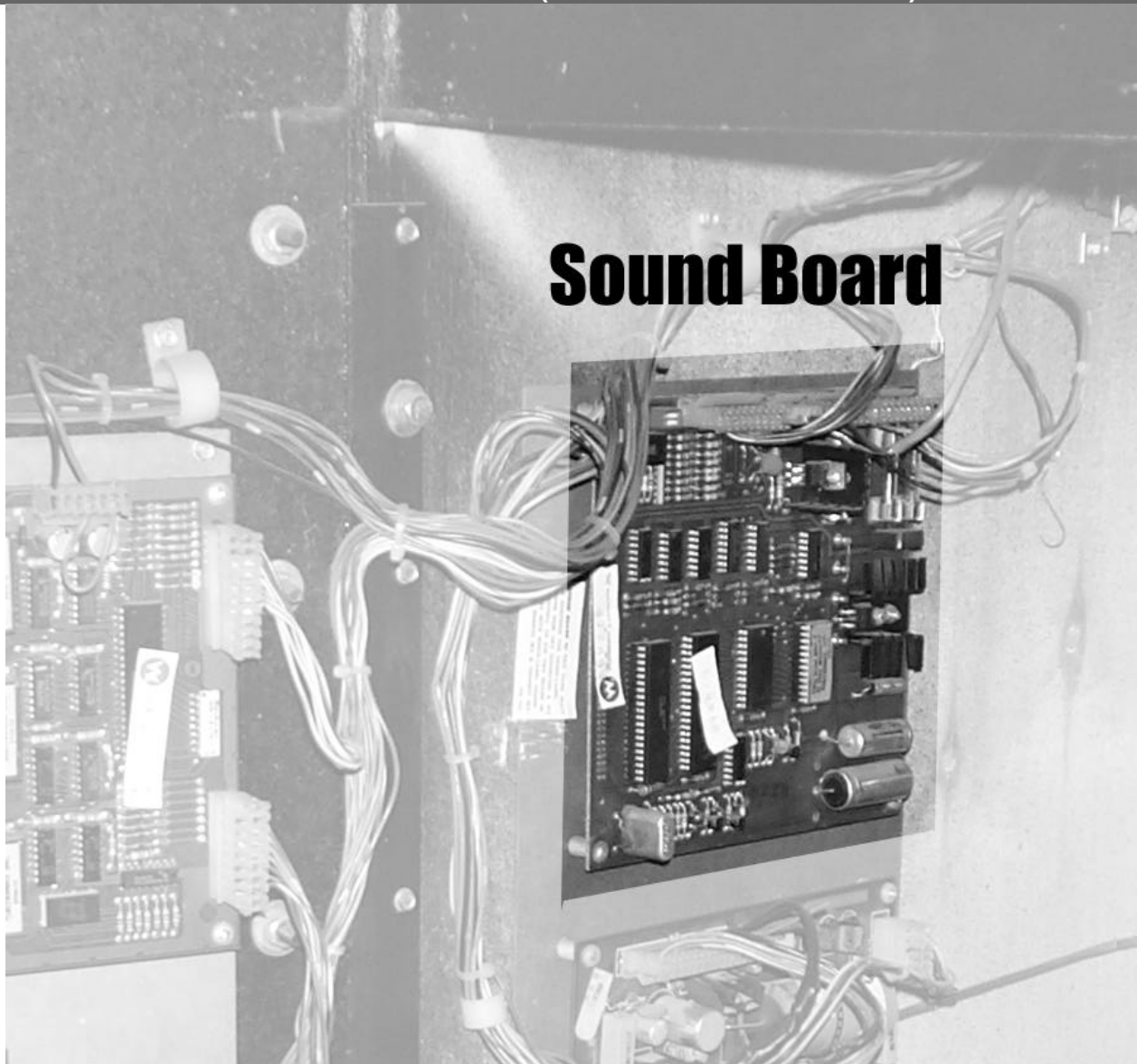
Preparing the ROM Board:

We will be removing several socketed chips from the Williams ROM board in preparation for installing the rest of the Multigame modification. Follow these steps:

- To protect any components from harm, touch the metal plate that the board are mounted to with a bare finger. (This will place you and the game boards at the same "ground" potential.)

- Locate the ROM board in the cabinet. Remove it if you feel more comfortable working on it outside of the machine, but carefully note where the cables go.

- The ROM board will have 12 socketed EPROMs (24 pin chips with a paper label on top.) Carefully remove all the EPROMs from their sockets and place them on some anti-static material. (Aluminum foil is fine.) You can save them someplace safe—they're not needed.

The picture below shows the board before and after and helps identify the chip locations:.

Board Before IC Removal	Board After IC Removal
EPROMs	Empty Sockets
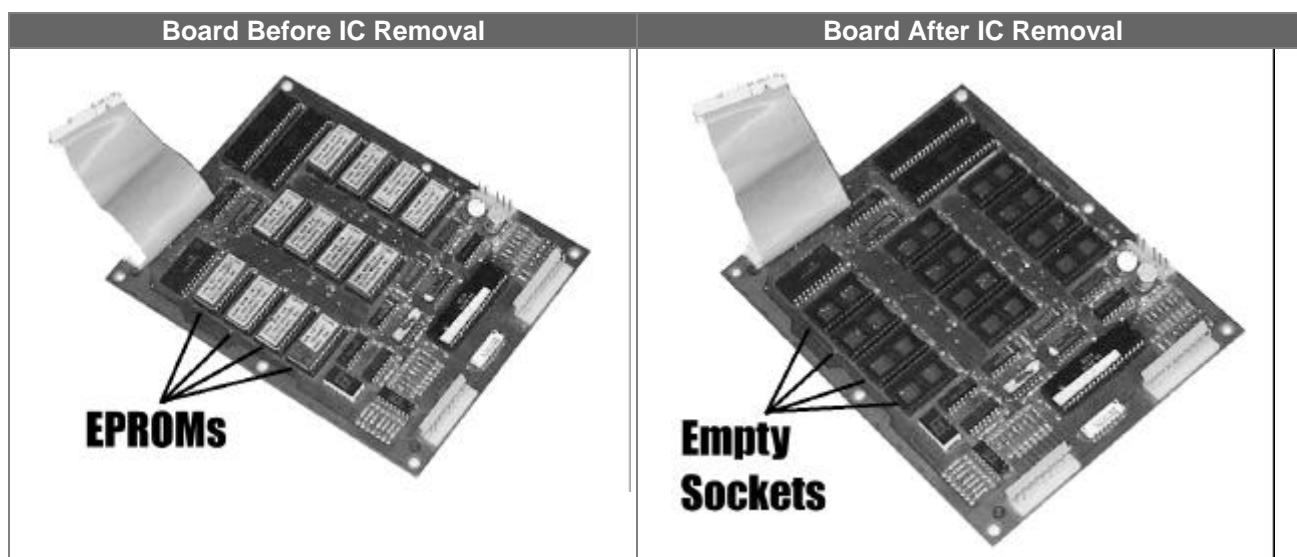
Preparing the CPU board:

The CPU board is where the main Williams Multigame components are installed. The following steps will detail how to prepare it for the main Multigame.

- To protect any components from harm, touch the metal plate that the boards are mounted to with a bare finger. (This will place you and the game boards at the same "ground" potential.)

- If you haven't already done so, carefully unplug the 40-pin ribbon cable that connects the ROM board to the CPU board.

- Locate the 20-pin ribbon cable that connects the Widget I/O board to the CPU board. Carefully unplug it.

- Disconnect the Widget I/O board cables and use an appropriate screwdriver to remove the Widget I/O board from the metal plate. It is no longer needed.

You should now have a CPU board that looks similar to the picture on the following page:

(Picture rotated 90 degrees clockwise)

CPU Board

Widget Connector

ROM board Connector
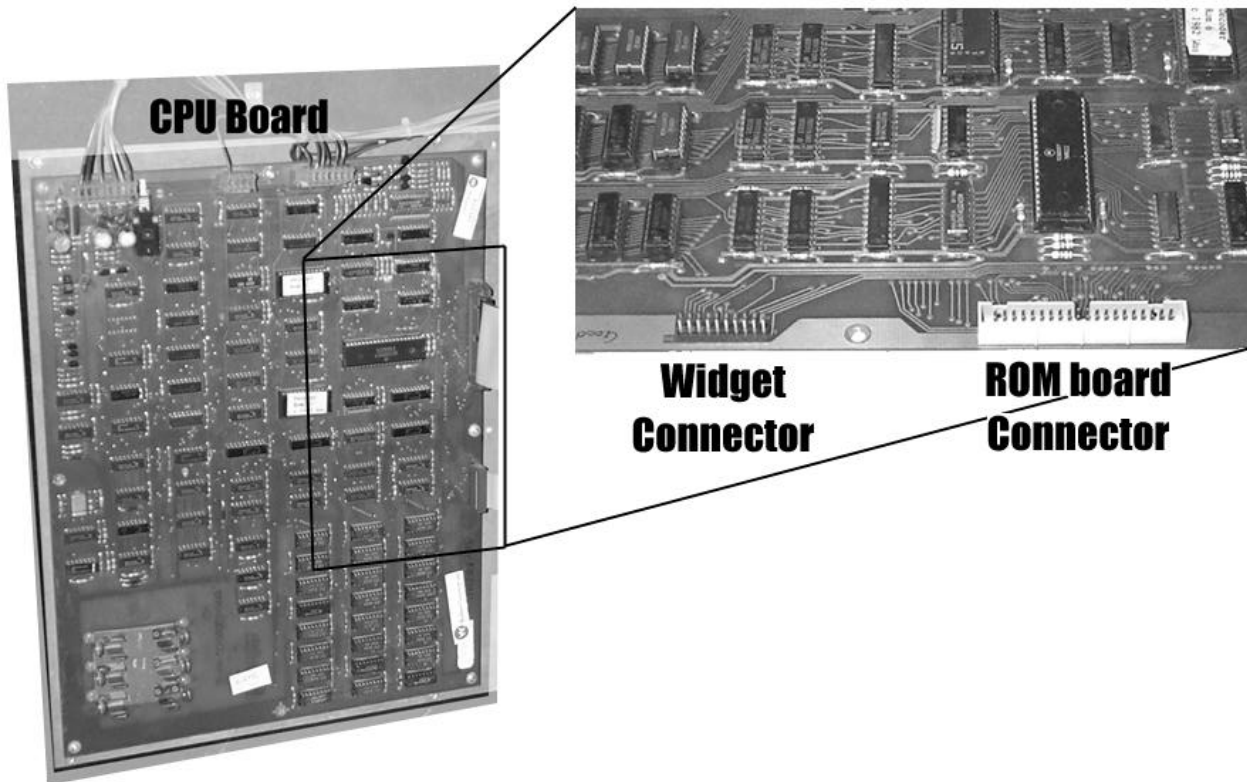
Preparing the Sound board:

Time now to deal with the final piece of preparatory work—the sound board. The sound board is usually located on the metal plate inside the cabinet with the power supply. Follow the next steps to get it ready or the Multigame.

- To protect any components from harm, touch the metal plate that the boards are mounted to with a bare finger. (This will place you and the game boards at the same "ground" potential.)

- There will be a single, socketed 24-pin chip on the sound board. It will be an EPROM (usually with a paper sticker on it). Use the pictures below to help locate it.

- Carefully remove the EPROM from the socket and place it on some anti-static material. (Aluminum foil is fine.) You can save it someplace safe—it is no longer needed.

The images on the following page should help make things clear:

Sound board before EPROM removal…	…and Sound board after EPROM removal.
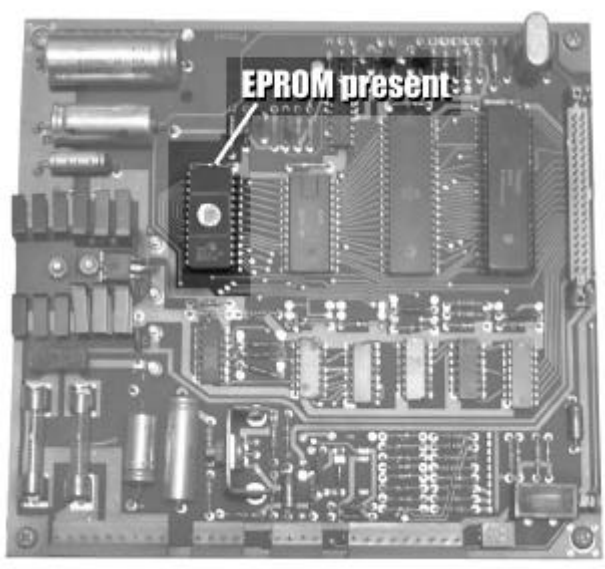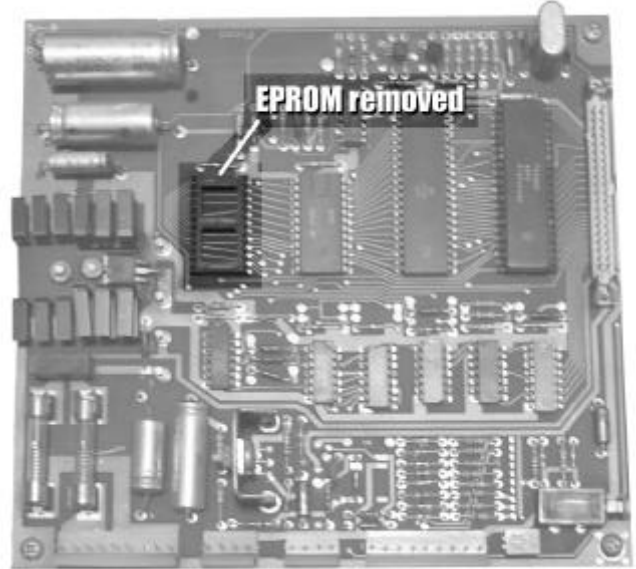
At this point it's worth mentioning that the Sound board you are using needs to be setup to use a 2532 type EPROM. If it's an original Robotron or Joust board, it should already be that way, but if it was hacked on or replaced with something else at some point it may be different.

Sound board jumpers for 2532 EPROM operation:
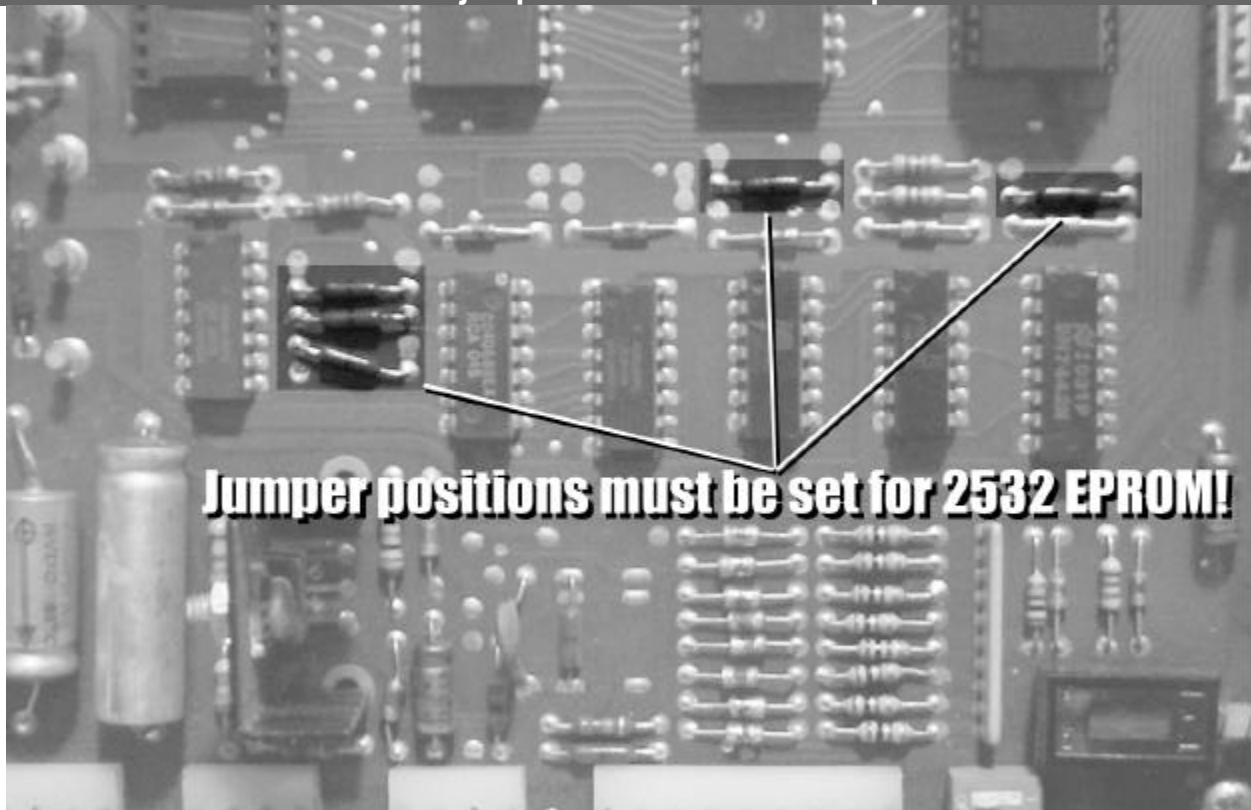
If your sound board is "jumpered" differently, you will need to convert it back to 2532 operation. Use the image above to correct the jumpers.

Pre-install work review:

Time to take a little break and review. At this point, you should have removed the Widget I/O board from the machine, unplugged the ROM board from the CPU board, and removed all the EPROMs on the ROM board and the Sound board. Hopefully you also know how to put things back together if you're decided to remove any of the boards from the mounting plate. You've also verified that your sound-board is configured for 2532-type EPROMs (or if necessary changed the jumpers to use 2532's).

Install the Williams Multigame boards:

You're now ready to install the Williams Multigame boards into your game. The Williams Multigame boards are labeled "CPU Expansion", "Sound Board Expansion" and "Widget I/O Controller". They are all tethered together by small ribbon cables. We'll start with the CPU board…

CPU Expansion daughtercard:

The following steps will install the "CPU Expansion" board.

- The "CPU expansion" card will plug into the 40-pin socket that the ROM board cable was previously connected to. Orient the "CPU Expansion" so that it lines up with the 40-pin connector, but so that the "CPU Expansion" board is over the main CPU board. (It shouldn't be hanging off into space).

- Carefully align the 40-pin connector down onto the pins of the 40-pin connector on the main Williams CPU board. Once you're sure that both rows of pins are lined up (and you're not "off by one" in any direction) firmly press the "CPU Expansion" board down onto the connector.

- Verify that the "CPU Expansion" board fits snugly and does not "flop around" on the pins. Depending on the type of 40-pin connector used on your original CPU board it may be necessary to cut down the plastic "ears" on the 40-pin connector to allow the "CPU Expansion" to seat all the way down on the connector. You want a good solid connection here.

There will be a black and a red wire "hanging off into space" from the "CPU Expansion" daughtercard. We'll deal with those in a minute, but for now use the image on the next page to check your work:
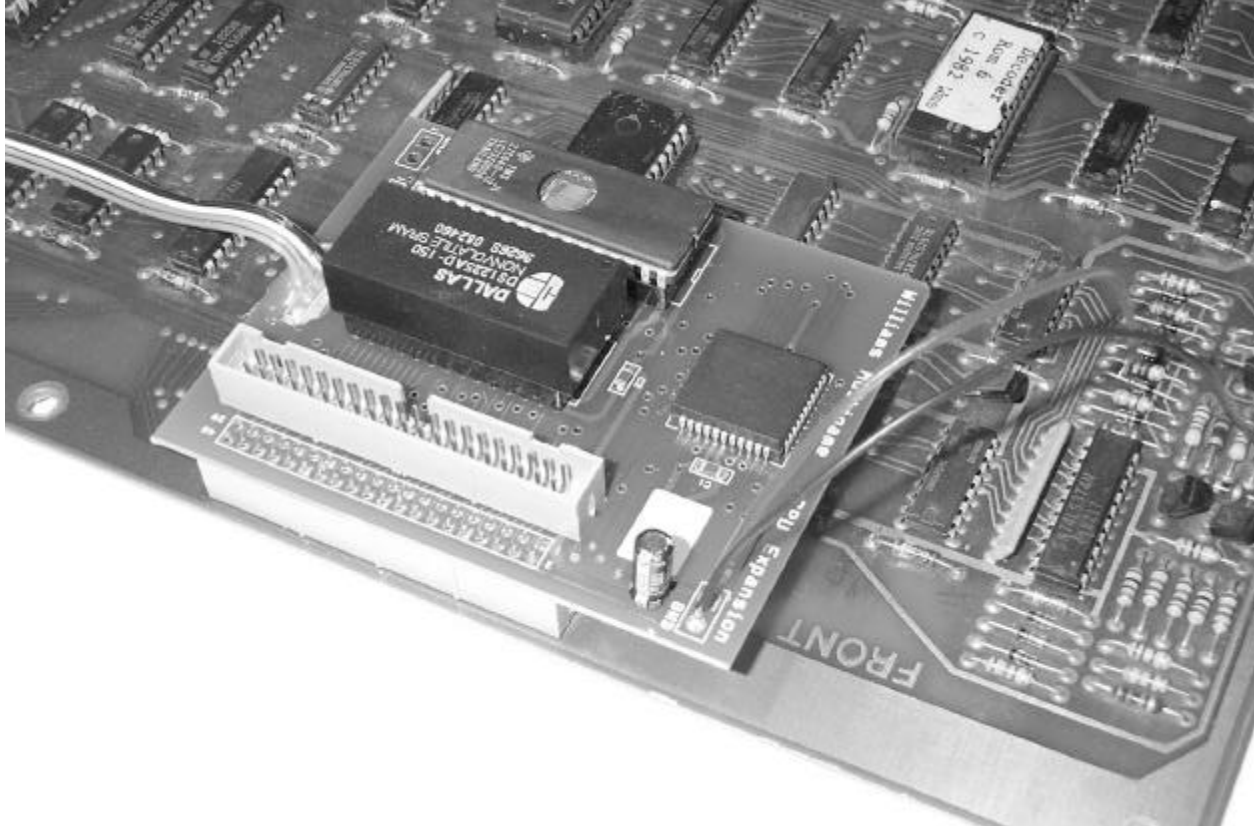
If your installation looks about like the picture above, you're ready to connect those two loose wires.

This is one point that you want to be really, REALLY, careful about your work. The Red wire needs to be connected to +5VDC and the Black wire needs to be connected to Ground. If you get this wrong, VERY bad things will happen when you turn on power. You have been warned…

In the corner of the CPU board closest to the "CPU Expansion" daughtercard, there will be some chips mounted on the original Williams CPU board. Those chips will have bypass capacitors located near their notched end. Unfortunately there is a large variety in Williams CPU's, so it's very possible/probably that the picture in this manual may not match your CPU board.

The bypass capacitors provide a convenient point to connect to the power supply since one end of them goes to +5VDC and the other end goes to Ground. You need to be SURE which end is which.

- Verify which end of a nearby bypass capacitor connects to ground and which end connects to power. You can do that with a Multimeter set to ohms (or diode test, or continuity check depending on your meter), or by VERY carefully following the trace to a nearby chip. A "7489" chip should be in that corner. Pin 14 of a 7489 (the top left pin) is +5VDC and Pin 7 (the bottom right pin) is Ground. Make sure you can CLEARLY see which one connects to which end of the bypass capacitor.

- Once you are really, REALLY sure where power and ground are, solder the Red wire to the Power connection (+5VDC) and solder the Black wire to the Ground connection (0VDC).

- Now that the soldering is done, you can go ahead and plug the ROM board ribbon cable into the 40-pin header on the "CPU Expansion" board. The connector is keyed, so the ROM board should only fit in one way—the orientation stays the same as when it was plugged directly into the CPU board.

You can use this picture for reference, although there's probably a 50-50 chance that your board may look slightly different:

Proper connection of +5VDC and GND on a Rev. C Williams CPU board

Red wire goes here, +5VDC

Black wire goes here, Ground
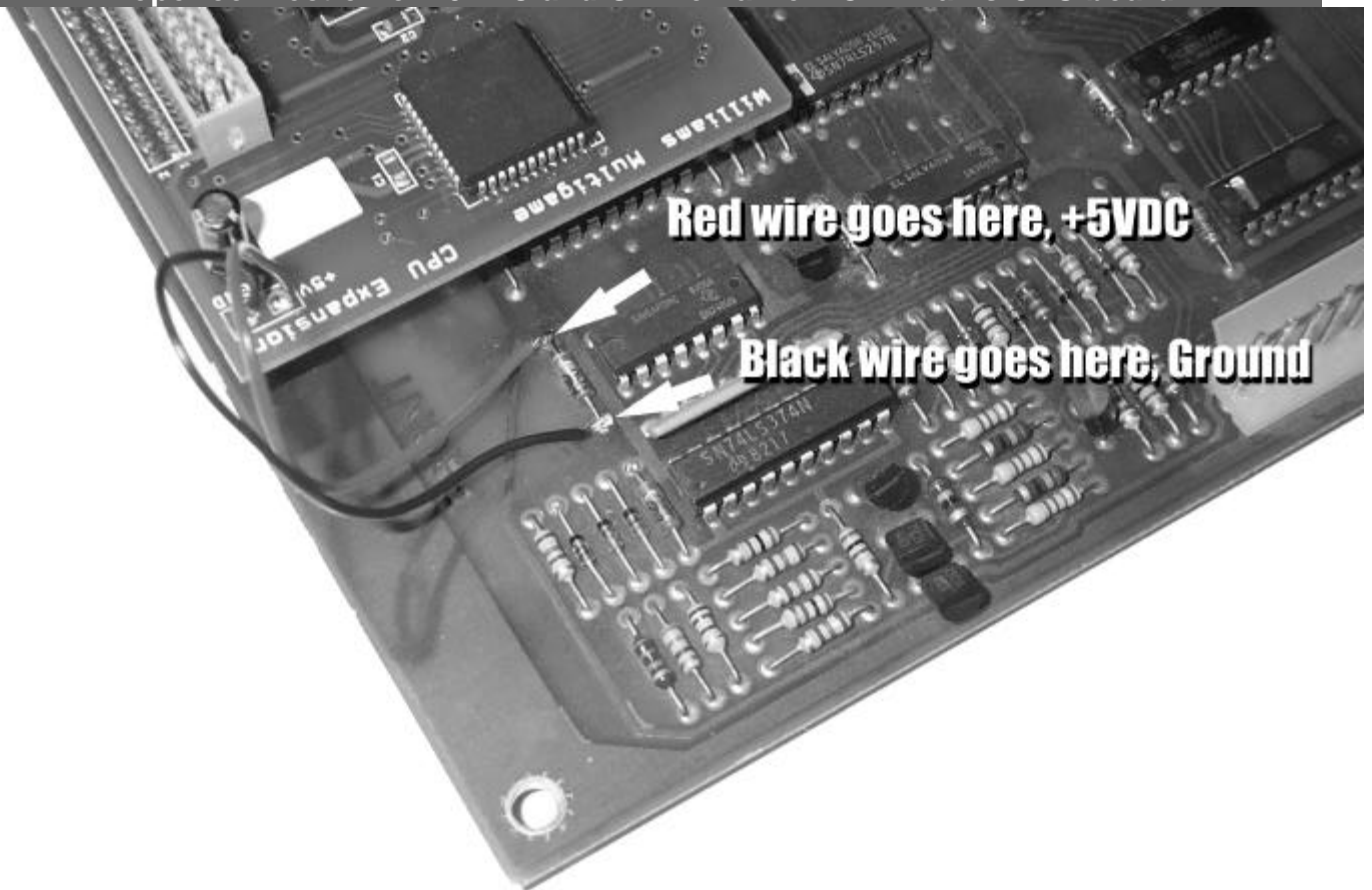
(If you don't like the idea of soldering directly to the original Williams CPU board you can extend the wires and connect them to any other known-good source of power. Keep the wires fairly thick—although the daughtercard is much lower power than the EPROMs it's replacing there are still fairly high-speed signals going on that can require a lot of current. Flakey power on the "CPU Expansion" daughtercard can lead to really strange problems that can be tough to diagnose!)

Now that the scary stuff is out of the way, take a deep breath, pat yourself on the back, and get ready for less harrowing adventures! (Oh, and double-check one more time that Red is connected to +5VDC and Black is connected to Ground.)

Widget I/O Controller daughtercard:

Compared to the "CPU Expansion" daughtercard, the "Widget I/O Controller" is a breeze. Follow these next steps to install it.

- Since the "Widget Controller" is attached to the "CPU Expansion" it is already in roughly the right location. Locate the empty 20-pin header that the original Williams I/O board connecter to. This time, orient the daughtercard so that it DOES hang off the edge of the main Williams CPU board. (In the same direction as the original Widget I/O board.)

- Carefully align the 20-pin connector down onto the pins of the 20-pin connector on the main Williams CPU board. Once you're sure that both rows of pins are lined up (and you're not "off by one" in any direction) firmly press the "Widget I/O Controller" board down onto the connector.

- Verify that the "Widget I/O Controller" board fits snugly and does not "flop around" on the pins. This connection is generally more forgiving than the "CPU Expansion" connector.

You should have something like this:

Proper orientation of the new Widget I/O Controller
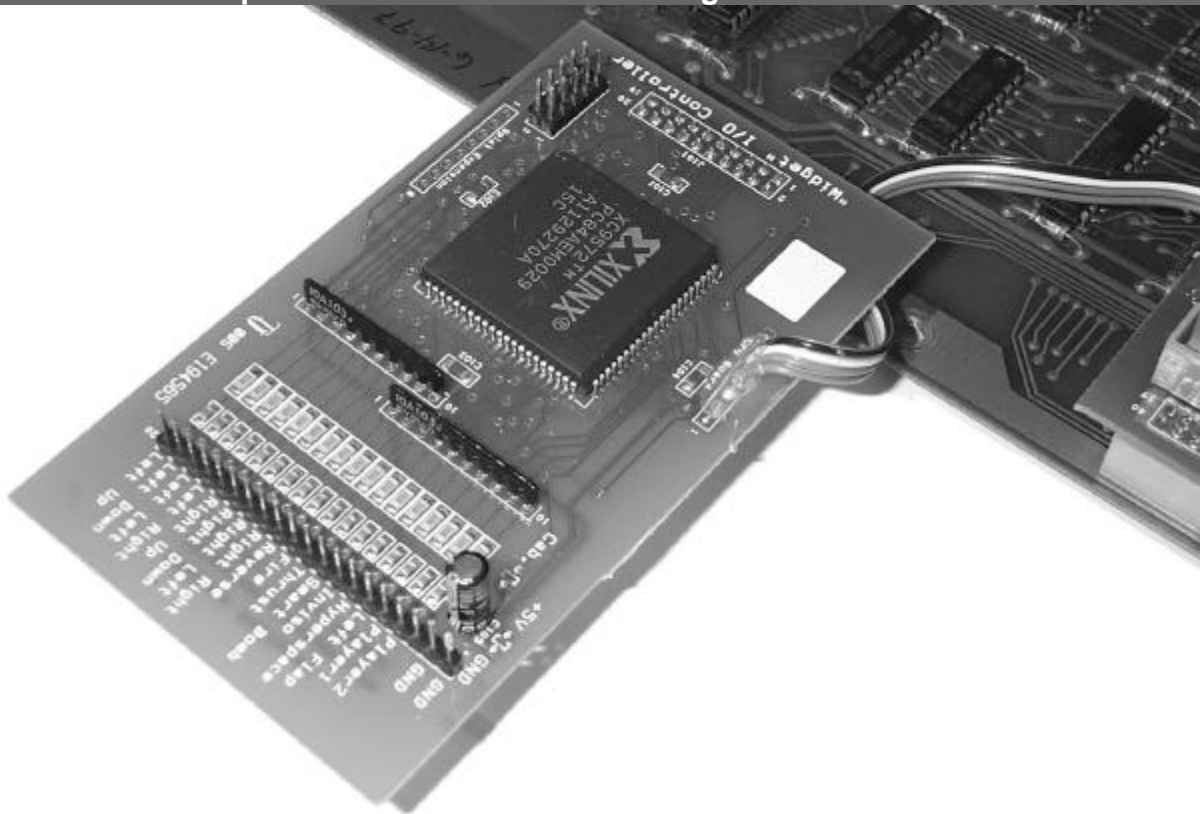
As seen from the reverse angle:
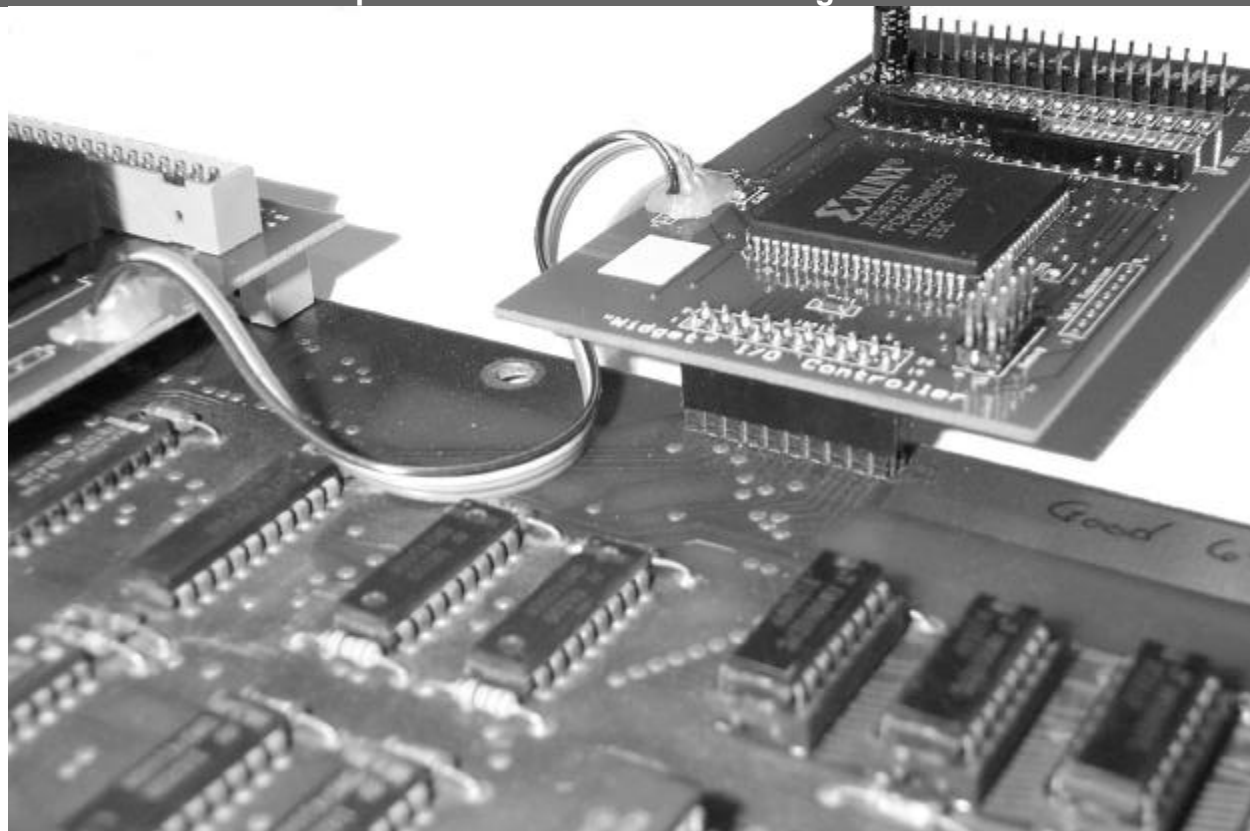
That basically completes the electrical install for the Williams CPU board! You're well on your way to being done!

Sound Board Expansion daughtercard:

The "Sound Board Expansion" will be installed on (you guessed it!) the Sound board. Follow the steps below to complete the installation of the daughterboards.

- Take the supplied 24-pin "dual wipe" socket and press it into the empty EPROM socket on the Sound board. (Yes, plugging the socket into the socket).

- Next, take the "Sound Board Expansion" daughtercard and orient it so that the notch on the EPROM on the "Sound Board Expansion" is pointed in the same direction as the rest of the large chips on the original Sound board. If the "Sound Board Expansion" is partially hanging over the finned-metal heatsink on the original sound board—you have it in there backwards. (Don't do that.)

- Press down carefully and the daughterboard should seat into the socket on the original sound board. Make sure you didn't bend any pins out or damage the connector or socket.

The following picture shows the installation of the Sound daughtercard:
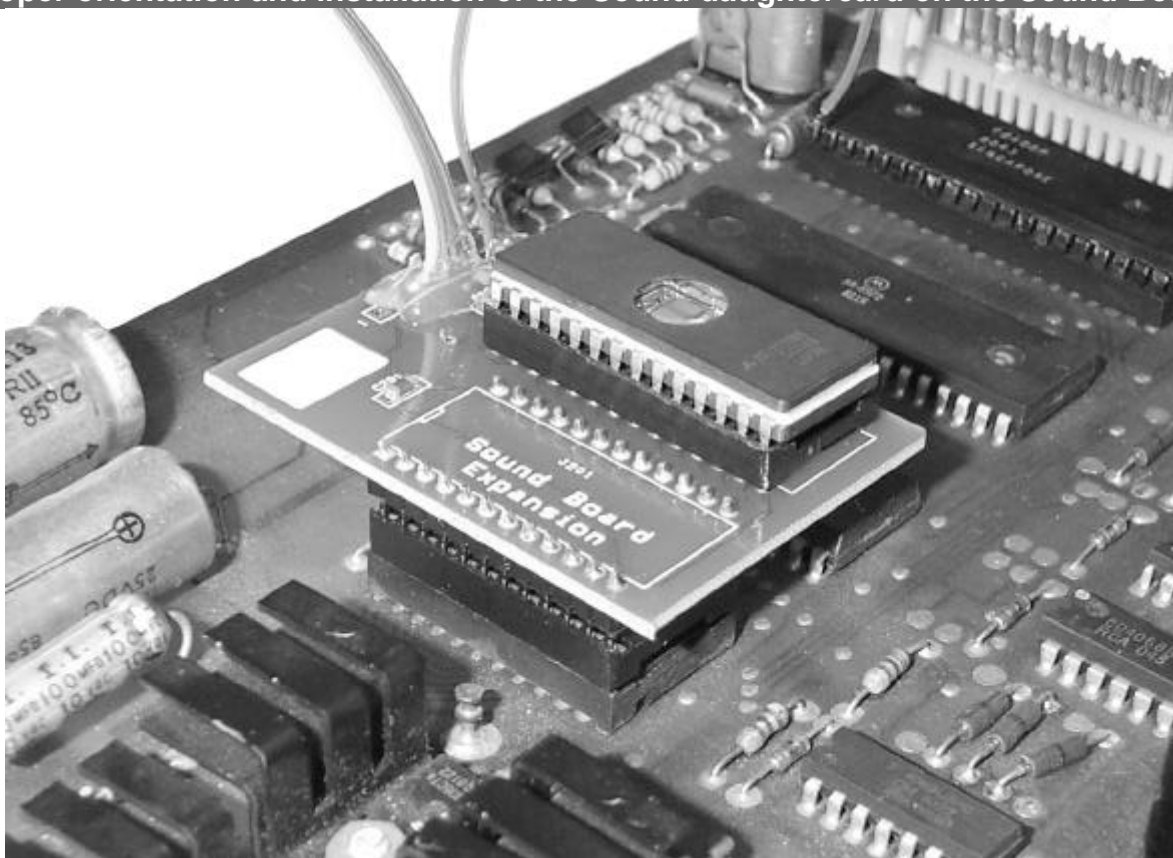
If your sound board's EPROM socket had been abused or damaged it's possible that it won't make good contact with the Multigame daughtercard and sound won't work right. If that happens, you don't have much choice but to replace the socket on the original sound board with the one that came with the kit.

You're probably wondering what that other "dangling" wire is for. It's used to reset the sound board automagically from the menu-software to keep any sounds from getting "stuck" when you exit a game and start the menu. It needs to be connected to the reset line of the sound board's CPU. An easy point to do this is on the "header" that goes to the processor on the edge of the board. Not all sound boards will have the header populated though, so you may have to do a little more thinking to find the right spot to connect It for your particular boardset. Follow the steps below to connect the reset wire.

- Locate the 40-pin header on the sound board. It will either have a 40-pin ribbon-cable type connector on it like the main CPU board, or it will just be two rows of silver pads (without the connector) on the Sound board close to the 40-pin CPU in the corner. Use the image below for reference.

- The reset wire needs to be connected to the 4th pin on the inside row, closest to the edge metal-can crystal and 40-pin CPU. If your sound board doesn't have a connector there, you can connect the wire directly to the PCB. If you have trouble locating the correct pin based on the picture and these instructions, you can simply solder the wire directly to Pin 40 of the 6808 (or 6802) chip.

The following image should help clarify where to connect the wire:

Sound board reset wire connects to the 4th pin on the inside row closest to the corner of the board.
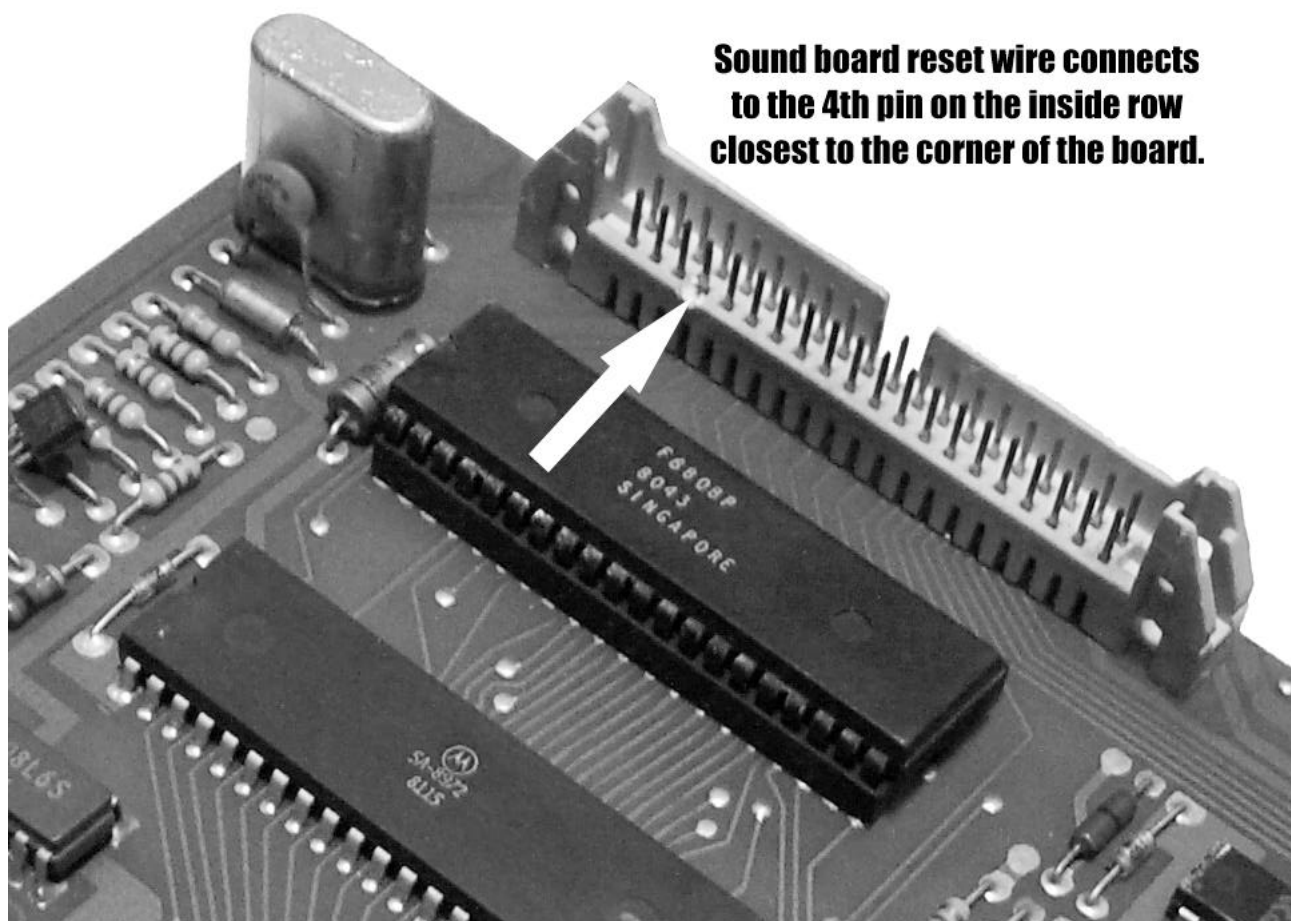
Congratulations!

You have now successfully installed the daughtercards into your machine! If you removed any of the PCB's or cables from the original boards, now is the time to put everything back together, double check your work, and triple check the power connection to the CPU Expansion daughtercard.

Quick test:

Once you're sure everything is connected right—plug the machine in and turn it on!

Right about now you're either ooooh-ing and aaaaahhh-ing at the Williams Multigame Menu, or you're starting to panic.

- If you get the menu on the screen you're good to go—proceed with the next section.

- If you're not seeing the menu, turn everything off and start with the troubleshooting section.

Adapt/Build/Buy a custom control panel:

This section is really more of a large "recommendation" than instructions. Along the edge of the "Widget I/O Controller" is a 20-pin header than has inputs for all the necessary game controls for all the games you can have in the Williams Multigame.

To have a fully functional machine (capable of playing all the games without changing any control panels or other hardware on the cabinet) you need:

- Two eight-way joysticks
- A pair of Start Buttons
- At least 6 push-buttons (Left Flap can be wired to another switch if desired, or it can have its own dedicated button bringing the total up to 7.)

How to build or wire a control panel is beyond the scope of this instruction manual, but in a nutshell you will need to connect "ground" from pins 1 and 2 on the Widget I/O Controller input header to one side of the normally-open switches found in control panel joysticks and buttons. The other side of each switch goes to the appropriate pin on the Widget I/O Controller.

The header on the Widget I/O Controller is a standard .1" square-pin header. You can solder directly to it if you like, but I would recommend using a cable connector of some sort. A cheap and easy cable to use is a standard 40-pin IDE cable. Plug one "half" of the IDE connector onto the Widget I/O Controller header, cut one end off the cable, and then use the wires to connect to your switches or to the optional JAMMA adapter or to your control panel directly.

The connector pinout is labeled on the "Widget I/O Controller", and is repeated here for convenience:

Pin Number	Function	Used By
1	Ground	All
2	Ground	All
3	No Connect	none
4	Player 2 Start	All
5	Player 1 Start	All
6	Left Flap	Joust
7	Hyperspace	Defender, Stargate
8	Inviso	Stargate
9	Smart Bomb	Defender, Stargate
10	Thrust	Defender, Stargate
11	Fire/Right Flap	Defender, Stargate, Joust
12	Reverse	Defender, Stargate
13	Right Stick - Right	Robotron, Joust, Splat!
14	Right Stick - Left	Robotron, Joust, Splat!
15	Right Stick - Down	Robotron, Joust, Splat!
16	Right Stick - Up	Robotron, Joust, Splat!
17	Left Stick - Right	Robotron, Joust, Splat!, Bubbles
18	Left Stick - Left	Robotron, Joust, Splat!, Bubbles
19	Left Stick - Down	Robotron, Splat!, Bubbles, Defender, Stargate
20	Left Stick - Up	Robotron, Splat!, Bubbles, Defender, Stargate

Once you have your control panel hooked up (or at least the Player 1 and Player 2 start buttons) you can proceed to the next section and get a hang of the menu system.

Using the Multigame:

First power-up:
When first turning on the Multigame you will see the Williams Multigame menu system. In all likelyhood the display will be set to the "Setup" menu, similar to the image below:

Directly under the Williams Multigame title is two rows of text instructions—these explain how to use the menu. In simple terms:

- Pressing the Player 1 Start button will cycle through menu choices.

- Pressing the Player 2 Start button will "select" the current choice.

Using the Multigame Menu System:

Go ahead and press the Player 1 Start button a few times. You'll see all the games cycle-past (regardless of if you programmed them onto the EPROM of not—we'll get to that in a second). If you press Player 2 Start on any of the games, you'll see the familiar "rug pattern" start as the game boots, then the game will be running! (Obviously, if you didn't have the game in the EPROM, choosing it from the menu won't start it!)

Press both Player 1 Start and Player 2 Start simultaneously to get back to the menu.

(You can repeat the above process to check out the games if you so desire.)

Set the Multigame menu back to the "Setup" selection and press Player 2 Start. You'll be taken to the configuration menu:

Williams Multigame

SETUP MENU V.1.1

→ CONTROL PANEL INPUT TEST
   SET DEFAULT GAME
   SHOW/HIDE GAMES
   ERASE SCORES/SETTINGS
   COLOR BARS
   CONVERGENCE GRID
   FAST BOOT CONTROL
   EXIT MENU

Menu Software © 2001, Clay Cowgill

Here again, pressing Player 1 Start will move the menu choice (the purple arrow on the left) and pressing the Player 2 Start button will execute that selection. Rather than step through each item, the following table explains the purpose of each menu and how to use it:

Williams Multigame

CONTROL PANEL TEST

LEFT STICK   RIGHT STICK
   LEFT   LEFT
   RIGHT   RIGHT
   UP   UP
   DOWN   DOWN

            FIRE
            THRUST
            REVERSE
            SMARTBOMB
            HYPERSPACE
       INVISO OR FLAP

PRESS P1 START TO EXIT

Menu Software © 2001, Clay Cowgill

The "Control Panel Test" menu is used to verify that your control panel connections are working. Pressing various buttons on the control panel will make their function "light up" onscreen. Note that the "inviso" and "flap" buttons share an input for the sake of this test—pressing either button should light the "INVISO OR FLAP" message. Pressing Player 1 Start will exit this function.

Williams Multigame

SET DEFAULT GAME

   MENU SYSTEM
   ROBOTRON
   JOUST   AUTO-START
   STARGATE
 → BUBBLES
   DEFENDER
   SPLAT!
   EXIT MENU

Menu Software © 2001, Clay Cowgill

The "Set Default Game" menu allows you to force the Williams Multigame to always start-up with a particular game selected. The menu will not be seen, and resetting the machine by pressing P1 and P2 Start simultaneously will just reset the game. In this mode, the game will appear to be a dedicated cabinet without the Multigame installed. By default, the "Menu System" is the default, but if you choose another game you will not be able to see the menu on power-up. To get the "Setup" menu back, you need to set the "Auto/Up" switch on (up position) your game and reset the machine (Press P1 and P2 start simultaneously). That will enable the "Setup" menu again. You must select the "EXIT MENU" item to exit this menu.

Williams Multigame
SHOW/HIDE GAMES

```
   SETUP MENU      ENABLED
   ROBOTRON        ENABLED
   JOUST           ENABLED
 → STARGATE        HIDDEN
   BUBBLES         ENABLED
   DEFENDER        HIDDEN
   SPLAT!          ENABLED
   EXIT MENU
```

Menu Software © 2001, Clay Cowgill

The "Show/Hide Games" menu allows you to disable games you didn't program on the EPROM, to hide games you did program but don't want to see, or to hide the "Setup" menu. Note that if you disable the "Setup" menu that you will not (normally) be able to get back to this screen. To get the "Setup" menu back, you need to close the "Auto/Up" switch on your game to "up" and reset the machine (Press P1 and P2 start simultaneously). That will enable the "Setup" menu again. You must select the "EXIT MENU" item to exit this menu.

Williams Multigame
ERASE SCORES/SETTINGS

```
   ROBOTRON
   JOUST
   STARGATE
 → BUBBLES         CLEARED!
   DEFENDER
   SPLAT!
   EXIT MENU
```

Menu Software © 2001, Clay Cowgill

The "Erase Score/Setting" menu allows you to wipe out the high-score/settings memory for any of the supported games. This will result in all the operator settings, programmable options, and scores for that game being erased and returned to factory defaults. You must select the "EXIT MENU" item to exit this menu.

The "Color Bars" will put up solid color bars on a black background on the display for use in checking proper operation of a color monitor. Press Player 1 Start to exit the color bars screen.
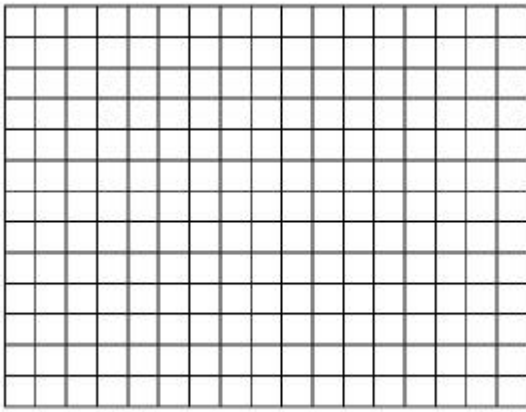
The "Convergence Grid" will put up a white on black grid on the display for use in converging a color monitor. Press Player 1 Start to exit the convergence grid screen.

Williams Multigame

FAST BOOT CONTROL

FAST BOOT   ENABLED
→ EXIT MENU

Menu Software ©2001, Clay Cowgill

"Fast Boot Control" is a special feature that will allow all the games in the Multigame to boot directly to their attract-mode screens. There will not be the "rug pattern" or and prompting if the high-scores are reset or even if the game is "fully operational". This allows for very quick changing between games, but at the expense of not running the self-test for each game. In general, you will want to run with "Fast Boot" disabled at least once with each game to allow it to intialize "normally". After that, "Fast Boot" seems reliable to use. This is a somewhat experimental feature, so if you ever have problems with a game switch back to "Fast Boot" being disabled to allow it to run full self-tests during boot up. (For example, if you erase the high-score and setting memory and try to boot a game with "Fast Boot" enabled it won't work. Just switch back to "Fast Boot" disabled and boot once, then switch back to enabled mode.) You must select the "EXIT MENU" item to exit this menu.

Miscellaneous Menu Features:

There are a few features of the menu that don't fit well into any real category, so I'll just list them here:

- The menu will always start with the last game/function you selected as the default choice. (If you ran Defender the last time you used the menu, Defender will be the default the next time the menu starts.)

- There is a screen saver that kicks in after about 15 minutes—it will dim everything on the screen about 50% to prevent burn-in on the monitor. Press either Player 1 or Player 2 start to return to normal brightness.

- Each game has its own high-score and settings memory—if you leave a game with credits on it and go back to the menu system, the next time you run that game the credits will still be there.

- Because I wanted to display the game "marquees" as quickly as possible there will be occasional little flashes of color on the screen when switching between options. This is normal.

The (optional) JAMMA adapter:

The JAMMA adapter is simple a JAMMA fingerboard that can be used to convert a JAMMA wiring harness into something suitable for use with the original Williams boardset. Building a complete JAMMA adapter will require wiring harness work which will be specific to how you plan on mounting the multiple game boards and as such is not included. There are people on the Internet selling ready-made Williams-to-JAMMA adapters as well.
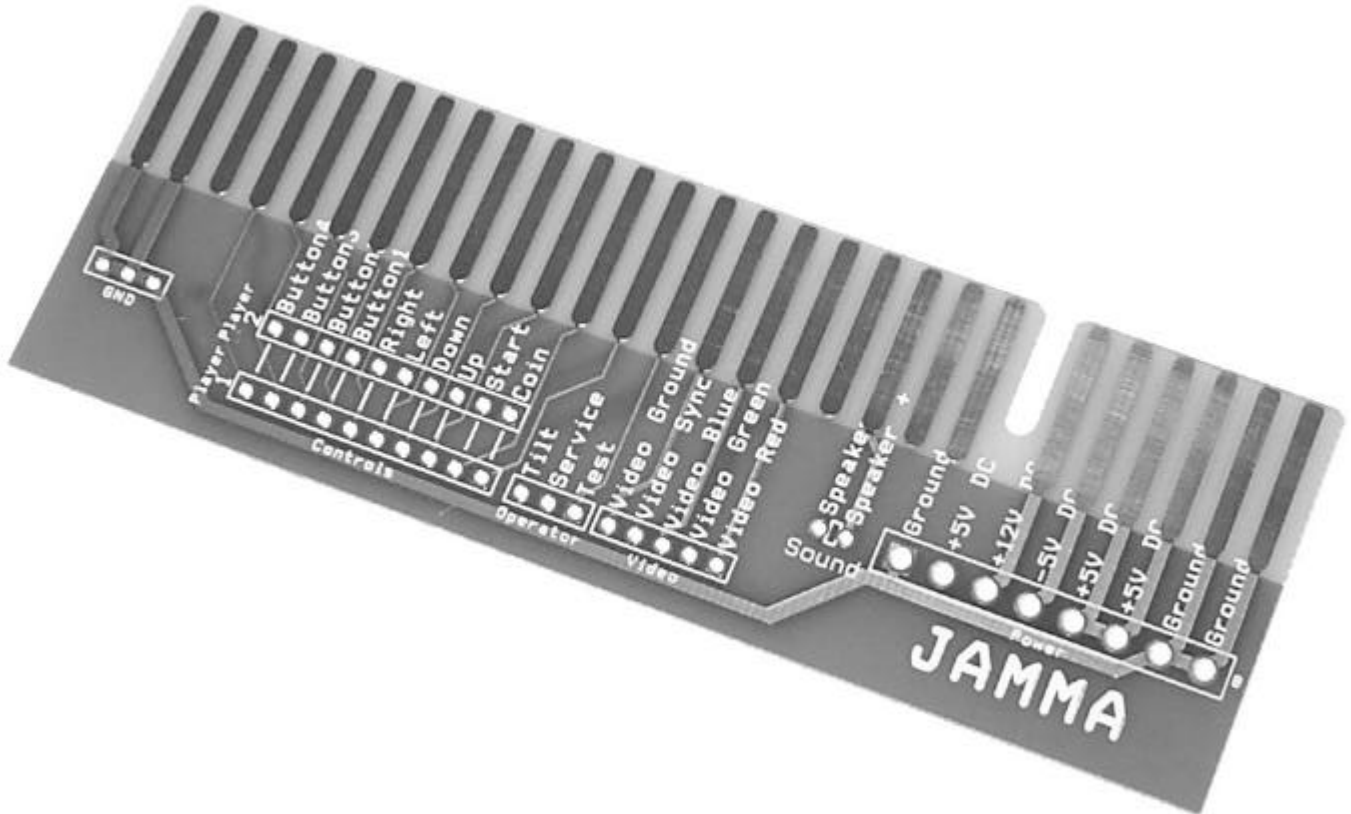
To connect the JAMMA adapter, you will need to refer to the wiring diagrams for your boardset/cabinet, especially if your cabinet or boards have been modified to use 64K DRAM chips or anything "out of the ordinary". The following pinouts are believed to be accurate for the majority of boards out there, but there are a lot of "tweaks" made to Williams boards and some variations from Williams themselves, so be careful and double-check everything with a multi-meter!

The basic procedure for building the JAMMA adapter is to connect power (+5VDC, -5VDC, +12V DC, and Ground), video, audio, and controls from the appropriate original Williams boards to the JAMMA adapter. You can solder the connections directly, but again, using connectors is strongly encouraged to make the process easily reversible and more flexible.

Power Connection:

Power connections are as follows: Connector "1J1" on the original CPU board is the power connector (consult your board and manual/schematics for exact pinouts and orientation). Connector "2J2" on the original ROM board is the power connector. You only need to supply +5V and Ground to the ROM board, but will need to supply +12V, -5V and Ground to the Sound board. Connector "10J1"

Pin	Connector 1J1 on CPU	Connect to JAMMA Adapter	Notes
1	GROUND	Ground (far right)	Power connections
2	GROUND	Ground (far right)	are on the right
3	GROUND	Ground (far right)	most side of the
4	key (no pin)	no connect	JAMMA adapter.
5	+12V DC	+12V DC	
6	+5V DC	+5V DC	
7	+5V DC	+5V DC	
8	+12V DC	+12V DC	
9	-5V DC	-5V DC	

Pin	Connector 2J2 on ROM Board	Connect to JAMMA Adapter	Notes
1	GROUND	Ground (far right)	Power connections
2	GROUND	Ground (far right)	are on the right
3	key (no pin)	no connect	most side of the
4	+5V DC	+5V DC	JAMMA adapter.
5	no connect	no connect	+12V is not needed
6	+12V DC	no connect	

Pin	Connector 10J2 on Sound Board	Connect to JAMMA Adapter	Notes
1	AC Voltage In	-5V DC	The sound board
2	AC Voltage In	no connect	was designed to run
3	no connect	no connect	off of AC voltages,
4	no connect	no connect	but DC will work
5	Ground	Ground (mid right)	fine. -5VDC is a bit
6	Ground	no connect	low, but since
7	key	key	JAMMA doesn't
8	AC Voltage In	+12V DC	have -12V it's as
9	AC Voltage In	no connect	close as we can get.

The sound board would really like to have -12V instead of just -5V, but -5V seems to work fine. If you have problems running the sound board, or if audio doesn't sound right you may need to get an additional power supply for the -12V supply for the Sound board. You could also connect the -5V supply directly to "Test Point 2" on the sound board which will save one diode-drop of voltage (about .7VDC).

Video Connection:

To connect video from the original CPU board to the JAMMA adapter, locate connector "1J3" on the CPU board.

Pin	Connector 1J3 on CPU	Connect to JAMMA Adapter	Notes
1	Red	Video Red	You must perform
2	Green	Video Green	the "sync inversion"
3	Blue	Video Blue	modification to the
4	Ground	Video Ground	CPU board for most
5	Vertical Sync	no connect	JAMMA monitors.
6	Horizontal Sync	no connect	(See below)
7	Composite Sync	Video Sync	

Sync Inversion Modification to CPU board:

In order to display properly on most modern monitors used in JAMMA cabinets, you will need to make a small modification to the original CPU board. Use the schematics and parts placement diagram in your original game manual to locate IC "4A". It is a 74LS86 chip. Pins 5, 12, and 10 will be connected together. Also connected to the pins is Resistor "R34". It is a 4.7K resistor (yellow-purple-red). Next to R34 there will be a solid trace in parallel with the resistor. It connects to ground. You will need to cut this trace. (Alternatively, you can cut pin 5 on IC "4A" loose from the circuit board and connect it to +5VDC.) Check the schematics before attempting this to be sure you understand what you're doing. If this is over your head, please have someone else perform the modification.

Speaker Connection:

Sound connections will come from the original Sound board. Connector "J2" on the sound board is used for the speaker output—it will be connected to the speaker inputs on the JAMMA adapter.

Pin	Connector J2 on Sound Board	Connect to JAMMA Adapter	Notes
1	Speaker Drive	Speaker +	(The polarity of this
2	Speaker Drive	Speaker +	connection doesn't
3	Speaker Ground	Speaker -	really matter.)
4	Speaker Ground	Speaker -	

Control Connections:

You will probably want to customize this layout a little depending on your JAMMA cabinet, but for this example I'm assuming you have a "standard" JAMMA cabinet with two eight-way joysticks and three fire buttons each.

Widget I/O Pin	Function	Connect to JAMMA Adapter	Notes
1	Ground	Ground (left side)	
2	Ground	Ground (left side)	
3	no connect	no connect	
4	Player 2 Start	Player 2 Start	This button layout
5	Player 1 Start	Player 1 Start	should be customized
6	Left Flap	Player 1, Button 2	depending on your
7	Hyperspace	Player 1, Button 3	cabinet panel layout.
8	Inviso	Player 1, Button 2	"Reverse" and "Flap"
9	Smart Bomb	Player 2, Button 3	share a button in this
10	Thrust	Player 2, Button 1	mapping.
11	Fire	Player 2, Button 2	
12	Reverse	Player 1, Button 1	
13	Right Stick, Right	Player 2 Right	
14	Right Stick, Left	Player 2 Left	Joysticks will need
15	Right Stick, Down	Player 2 Down	to be 8-way sticks
16	Right Stick, Up	Player 2 Up	for Robotron and
17	Left Stick, Right	Player 1 Right	Splat! to work well.
18	Left Stick, Left	Player 1 Left	
19	Left Stick, Down	Player 1 Down	
20	Left Stick, Up	Player 1 Up	

Operator control/Coin connections:

These will vary by cabinet type, but in general you will want the "Auto-up" switch to be a toggle switch so that you can "close" it and leave it set in order to reset the menu if need be. This switch can be connected to a "push-button", but you will need to hold it down on power-up if you want to reset the "Auto-boot" parameter or to recover the "Setup" menu if you've disabled it.

These connections are come from the ROM board at connector "2J2"

ROM Board "2J3"	Function	Connect to JAMMA Adapter	Notes
1	Auto/Up switch	Test switch	If desired, you can add
2	Advance switch	Service switch	an extra push-button for
3	High Score Reset	(no connection)	the high-score reset
4	Coin A	Player 1 or Player 2 Coin	switch. You may also
5	Coin B	Player 1 or Player 2 Coin	wish to have the Auto/Up
6	Coin C	Player 1 or Player 2 Coin	switch be a toggle-type
7	Slam	Tilt	switch. Experiment with
8	no connection	no connection	different coin connections
9	key	no connection	to get what you want.
10	Ground	Ground	

Troubleshooting:

Make sure there's nothing silly wrong like the machine's unplugged, one of the power-interlock switches is off, etc. If that all checks out OK, go back and check that all the daughtercards are plugged in properly, nothing has any bent pins, and no cards are loose or flopping around. If that all looks good, fire up the machine and check your power supply voltages and the voltages on the daughtercards (the "CPU Expansion" and "Widget I/O Controller" boards have a couple easy spots to check power). Power should be +5VDC within about 10% and should be relatively free of power supply ripple. If you're getting good power and you're sure everything is installed correctly, be suspicious of the connectors on the CPU board and of the EPROMs you burned earlier. You may need to replace any connectors if they've been bent or too "torn-up" over the years from things being connected or disconnected. When all else fails, the board will need have full troubleshooting done by someone familiar with electronics (and preferably video games). Although unlikely, it is possible that something will decide to just die simply from moving things around. You should try re-seating socketed chips and connectors, and look for cold solder joints on all connectors and IC's. There are numerous resources on the World Wide Web for help in trouble-shooting games.

- All kits are 100% tested prior to shipment, so a "bad" board is fairly unlikely. The single greatest point of failure will be sockets/connectors. If your original Williams boards have been worked on, or have different connectors than "usual" boards, it may be necessary to remove and replace the connectors with new ones. Http://www.multigame.com has replacement connectors available for a modest charge.

- Double check your solder connections on the main CPU board and Sound board. A tiny splash of solder onto the traces or pins of an IC can cause problems if it shorts to a neighboring signal.

- Sometimes handling the Williams boards can cause problems—you may need to resolder the connectors between the boards or wire harness. The pin connections often separate with time and age.

- If double checking the installation doesn't fix any problems you can backtrack and remove the kit and try your original game ROMs back in the boardset. If a problem persists with the board at that point, you should refer to one of the Williams Troubleshooting references on the World Wide Web, or the original service/operators manual. (Or contact a professional for repairs.)

- If you're still stuck contact me at: clay@yahoo.com and I'll try to help debug the installation. Unfortunately, due to time and space constraints I can not accept any boards for repair or installation.

Tips:

- Remember to return the "Auto/Up" switch to "off" (Manual/Down) after using it to reset Auto-boot and/or recover a hidden "Setup" menu.

- Try to use a cable with the "Widget I/O Controller" board connections. Even if you think you'll get everything right the first time directly soldering to the pins, it will be much easier if you ever decide to remove the kit or need to repair the original PCB's if you can simply unplug it.

- Although mentioned before, if you elect to extend the power wires from the "CPU Expansion" board, use at least 22 gauge wire.

- If your cables going to the "Widget I/O Controller" board will be heavy, or if there is some way they could be "pulled on" after installation, you may with to put a piece of styro-foam (or any non-conductive material like wood or plastic) behind the "Widget I/O Controller" board and glue it into place (so just it couldn't be pulled loose).

That's all!

I hope you enjoy the Williams Multigame. Please check out http://www.multigame.com for other multigame kits and developments!

Credits:

Many people over the years have been hacking and working on Williams arcade game hardware. A lot of this kit is based on their work, suggestions, ideas and general support and nagging.

- Sean Riddle - probably the best known Williams multigame hacker. I used some of Sean's firmware patches and tools to make this kit a reality.

- John Honeycutt - another Williams multigame home-brew hacker. John got to listen to me whine about debugging things and generally kick around ideas.

- Doug Jefferys - As far as I know, Doug was the first person to work on and document some of the early Williams hacks in a manner that could be understood by mere mortals. His texts are still a good reference half a dozen years later!

- Graham Bisset - Did a dandy write-up on converting a Joust-to-JAMMA.

- Michael Lenardon - Kept reminding me to work on the Williams Multigame instead of other distractions!

- Duncan Brown, Ray Ghanbari, Paul Astrachan, Kurt Mahan, Steve Ozdemir, Franklin Bowen, and Sean Riddle (again) for being the original Williams Hacker List guys.

"Ultimately, I am considering using my Robotron cabinet as a horizontal JAMMA cabinet to play all my horizontal raster games…"
-Ray Ghanbari
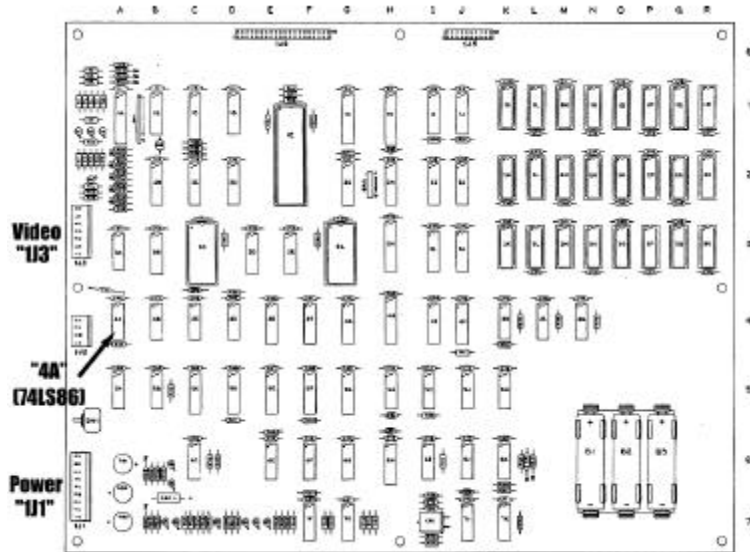Date: Mon, 5 Jun 95 14:12:28 -0500

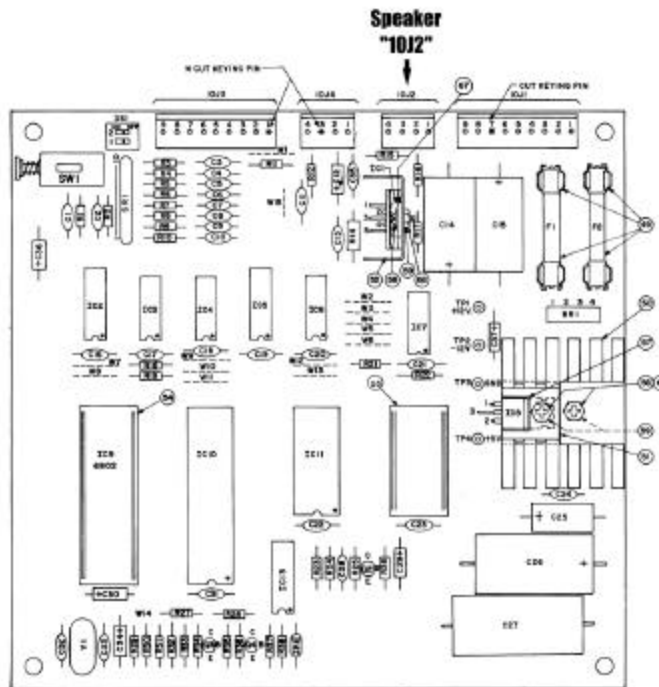How times have changed! ☺
-Clay

Reference:

The following diagram shows the typical locations of connectors used with the JAMMA adapter. Note that there are numerous variations of Williams boards, so always consult your own documentation and check your boardset connections with a multimeter before connecting power/video/sound/controls/etc.

CPU Board:

Sound Board:

ROM Board: