How to build a paddle controller for the Intellivision or the ColecoVision

V0.11

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E-beg

So, I originally did this because I wanted a paddle controller for kaboom on the CV. I spent lot of time and money designing these paddles.

I ended up selling a handful of the IntelliPaddles. Decided selling wasn't my thing for many reasons, so decided to open this up so people could make their own for their own personal use.

If you like this, you can always find the 3-d model on thingiverse and click on 'tip designer'. Thanks!

License

I don't have a license specifically, but here are the rules I would like people to follow.

1. Create a paddle and enjoy!
2. Create one for a friend, but please don't charge more than materials and maybe a six pack for your time.
3. If you wish to sell, contact me. We can try to work something out.
4. If you have suggestions for the software, please do a pull request.
5. If you make change to anything, please credit me as the original designer.

Disclaimer

I take no responsibility for any damage to any system, person or property caused by building or using the controllers.

Overview

These instructions will show how to build a paddle controller for either the Colecovision or the Intellivision systems.

The intelliPaddle will easily work with any model 2 system, and with a little modification to other models can be used with them also.

The ColecoVision Paddle Controller, CVPC, can be used with the ColecoVision system as well as other systems that a standard Atari 2600 Joystick will work with.

How does the paddle controller work?
The PCB contains three main components:

- ATTINY – this controls everything
- A 2x (IntelliPaddle only) and a 4x Optocoupler

Additionally, there is a 600 P/R rotary encoder attached to the ATTINY.
The ATTINY reads the pulses sent by the rotary encoder and determines if the paddle has been turned, if so, it determines the direction and send the appropriate signal to the 4x optocoupler. The optocoupler will connect the appropriate pins on the DP9 pin so the system will react accordingly. To sum it up, the paddle is acting like a joystick, it just presses the left, right, up or down button x times based on how fast you turn the paddle. The optocouplers are there to isolate the power between the circuit and the system.

BOM – Bill of Material

Item	#	Source	Note
3D Printed Case	1	Thingiverse	
circuit board	1	OSHPARK	
ATTINY84-20PU	1	Amazon	
Controller software	1	github	
fire button - 16mm round toggle switch	1	Amazon	
power switch with 9v battery connector	1	Amazon	
Step-Down Linear Voltage Reg.	1	Amazon	
Power LED 5mm	1	Amazon	
Joystick cable	1	Console5	Might be able to salvage
8 pin DIP socket (optional)	1	Amazon	Note Required, suggested
14 pin DIP socket (optional)	1	Amazon	Note Required, suggested
16 pin DIP socket (optional)	1	Amazon	Note Required, suggested
dip switch 2 position	1	Amazon	
470-ohm DIP resistor array 9 pin A471J	1	Amazon	
600 P/R Rotary Encoder	1	Amazon	
PC847 4x OptoCoupler	1	Amazon	
PC827 2x OptoCoupler	1	Amazon	IntelliPaddle only
M3 3 mm x 5.3 mm female brass threaded insert	3	Amazon	Optional
M3 x 16mm	3	Amazon	Optional
2mm x 6mm self-tapping screws	4	Amazon	Optional
Wires			Can use wires from Rotary Encoder.
Shrink Tubing			Optional
Zip Ties	2		Optional
ATTINY Programmer		Tindie	Optional, there are other ways to program the chip. Look on the internet.

Additional items you may/will need

- Soldering Iron
- De-soldering iron or wick
- Wire cutters
- Wire Strippers
- Multimeter
- Hot glue gun
- 2.5mm hex screwdriver
- Pliers
- Needle nose pliers
- Tweezers
- Solder
- Flux
- ATTINY Fuse repair - FuseRepair
- Joystick Y connector - Oshpark

What the parts look like

Before we start

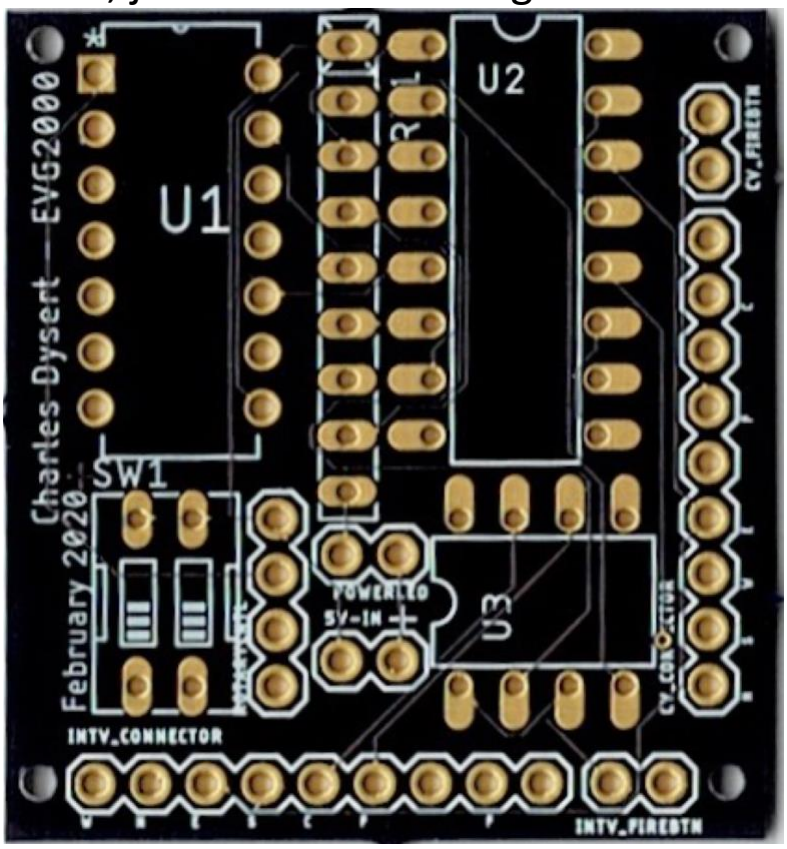
You have a few options on how you build your paddle:

1. Case options
    a. The simplest option is to use the top that doesn't contains screw hole.
        i. Pros:
            1. Easier to assemble.
            2. Easier to change battery.
        ii. Cons:
            1. Over time the lid may loosen.
    b. Option 1 using the lid with screw holes. Just use the bolts screwed into the plastic, the first time will take a little effort, but after that is shouldn't be too bad. This is the most preferable method.
        i. Pros:
            1. More secure assembly.
        ii. Cons:
            1. Harder to replace battery.
            2. Plastic may eventually strip.
    c. Option 2 using the lid with screw holes. Install the brass threaded inserts.
        i. Pros:
            1. Stronger construction.
            2. Plastic won't strip over time.
            3. Nicer overall, more professional.
        ii. Cons:
            1. Inserts are hard to install properly.
            2. Adds cost to the build.

2. Use sockets for chips.
    a. Pros:
        i. Easier to build, don't have to worry about damaging the ICs while soldering.
        ii. If a part is bad, easier to replace.
        iii. If a software update occurs, much easier to remove the ATTINY from a socket as opposed to unsoldering the chip.
    b. Cons:
        i. Minor additional expense.

Overview of the PCB

This is an older version of the PCB, the position of items is the same, just some text changes.



U1 is the ATTINY microprocessor, right below it is the DIP switch for changing direction and orientation. Below that is where the controller cord is connected for the IntelliPaddle. The last two connectors in the bottom right corner is where the fire button connects. Along the right edge is where the joystick cable connects for the ColecoVision Paddle Controller. The top two connectors are for the CVPD fire button. U2 and U3 are the 4x and 2x optocoupler respectively. U3 is only used for the IntelliPaddle. To the left of U3 if the Power LED and power in connectors. To the left of these connectors is where the rotary controller connects. To the left of U2 is the 470-OHM resist

Getting Started

3D print everything.

Head out to thingiverse and download the STLs. Printing should be pretty easy. I've designed the models so no supports should be necessary, post cleanup will be minimal and print time is reasonable. Only print the parts you need; you won't need both placards or both tops. I think print time is 8 – 10 hours. My original design was 24+ hours and required a lot of post processing.

Prepare the ATTiny84

Download the source code from github, open in the Arduino IDE, compile and program the ATTiny. There is plenty of information on the internet on how to program the chip, and you can either purchase a programmer or just breadboard one for this one project.

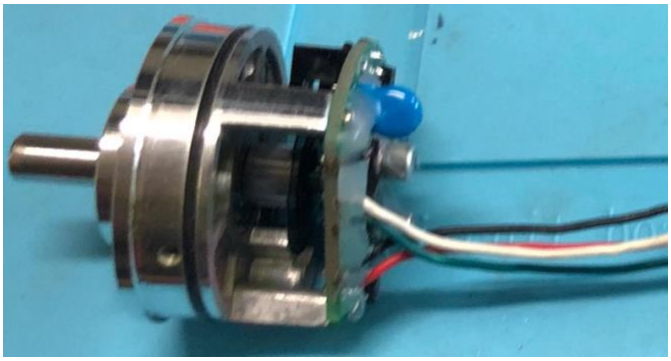
Prepare the rotary controller

First, we'll install the knob on the rotary controller.
You will notice two things about the knob.

- The knob is fairly solid, the reason being the extra weight makes it so the paddle can also act like a spinner.
- You will notice there is a line near the shaft hole, the flat edge on the shaft should line up with this line.

Pushing the knob onto the shaft will require a lot of force, and once on will be difficult to remove. See picture below to see approximately how far the knob should be pushed down. As you push the knob on, stop when you get close the final position and make sure the knob still turns freely. Press a little further on, and then retest. About half the silver lip should be visible. If the knob does not turn freely, the knob is pressed on too far. Carefully try to pull it back up.

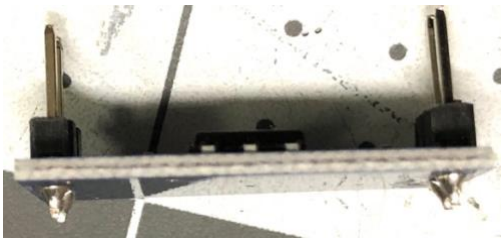
Trim the cable to about 12”, save the piece you cut off as you can use the wires later. You will either have nut, as in picture above or a rubber grommet. If you have the nut carefully remove the nut, if you have the grommet carefully cut it off at the rotary controller. Once you have done this, there are 3 small screws to remove. Once the screws have been removed, carefully remove the metal case. Once the case is removed, carefully pull the black plastic cover off of the wires. You will notice a braided metal wire, carefully cut and remove this. You should now have something similar to the picture below.



Notice the blue capacitor sticking out. This is the first rotary controller I’ve had that there was a capacitor sticking out this far. I modified the controller top to have an opening to accommodate this. Keep this in mind when installing into the top of the case.

Prepare the Voltage regulator

If your voltage regulator has pin headers, unsolder the pins so we can connect the wires.

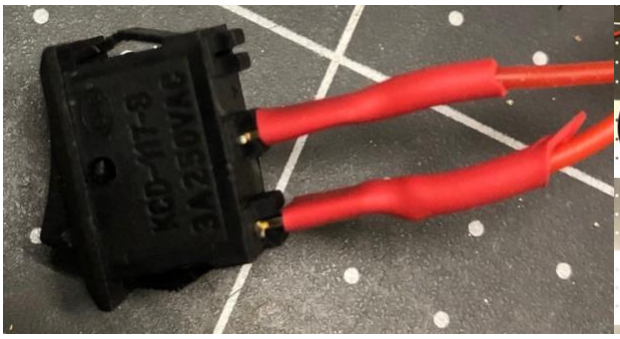


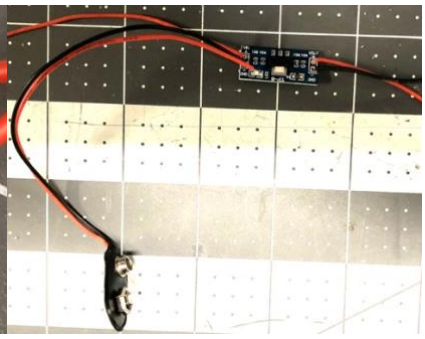
After removing the pins, hookup the regulator to a bench power supply set to 9 volts. Then adjust the output voltage to about 5 volts. You can also temporarily connect it to a 9-volt battery.

Connect wires to the output connections. You can use a few inches of the wire salvaged wire cut from the rotary controller.

Prepare the Power switch, and the 9-volt connector

One end of the power switch connects to the power-in connection on the regulator. The positive, red, wire from the 9-volt connecter goes to the other terminal of the power switch. It's a good idea to use shrink tubing, but that's your call.



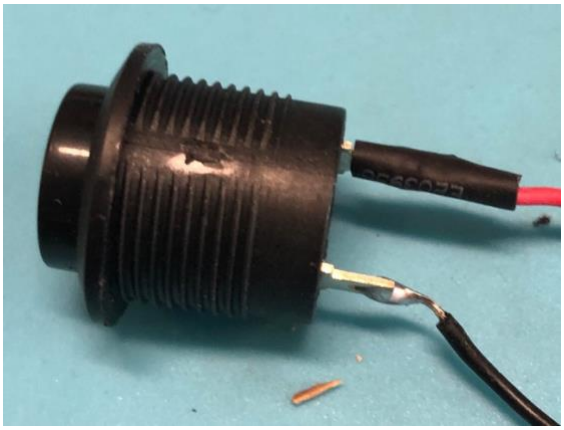


Prepare the Power LED

Cut a red and black wire, about 3” long, from the salvaged piece of wire cut from the rotary controller. Clip the leads of the LED, remember which leg is positive and which is negative. Long lead should be positive. Connect red with to positive, black to negative. Shrink tubing suggested, your call.

Prepare the Fire button

Connect a few inches of the salvaged wire, color not important. Connect a wire to each side of the fire button. Shrink tubing suggested.



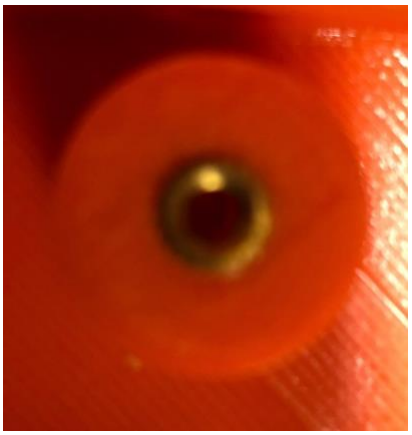
Prepare the Joystick cable

You can salvage a cable from another controller, such as a genesis controller. If you do reuse a cable, verify all of the wires are connected and working.

Remove about 65mm of the casing from the joystick cable. Strip the nine wires and tin the tips. You will probably need to use flux.

Install the female brass threaded inserts - optional

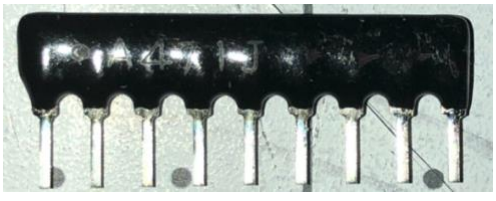
You will need to use a soldering iron or a special tool to melt the inserts into the 3 locations.

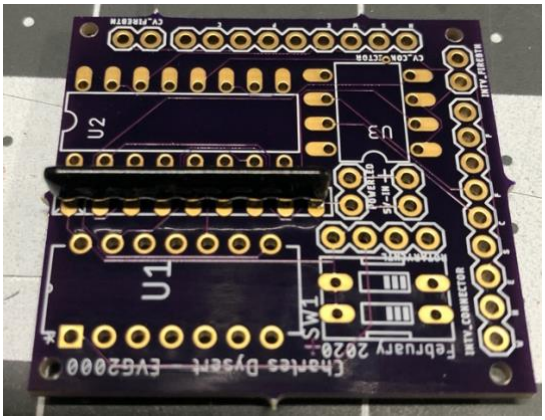


Start installing components to the PCB.

Install the Resistor network

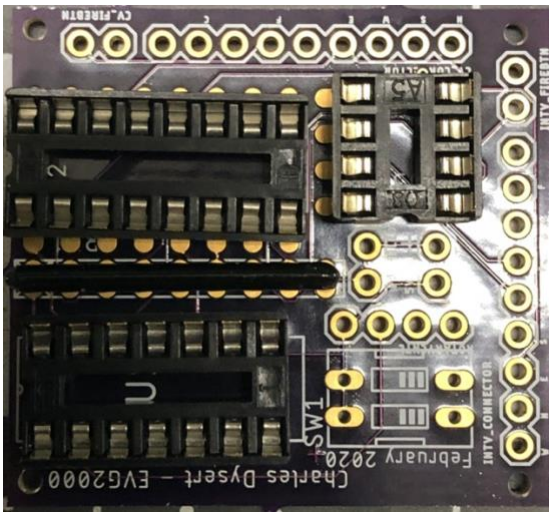
Looking at the resistor network one side will have writing on it, and usually a mark on the left side to indicate the common connection. It's be best to confirm the common pin by using a continuity test. Check pin 1 (common) and pin 2 for continuity. The resistor network is installed between U1 and U2. Pin 1 is next to the edge of the board, the is a box with an x through it.





Install the IC sockets

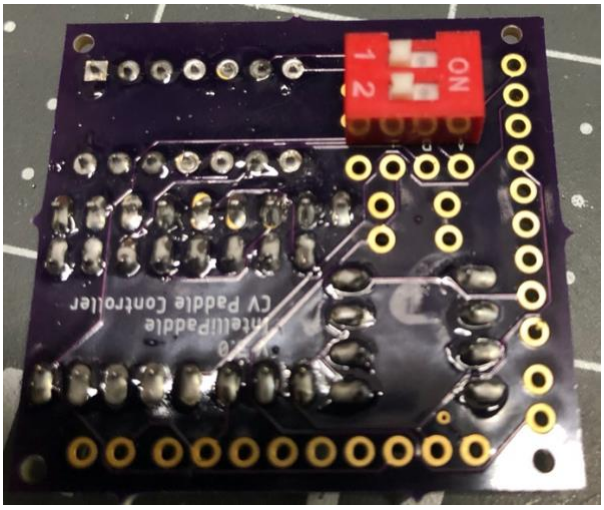
If you are using the IC sockets, install them now. I highly recommend installing them. Makes it easier if you want to update the software, or a chip goes bad. If you are making a CV Paddle Controller, you don't need the 8-pin socket. Install the sockets with the notches matching the image on the PCB.



Install the DIP switch

The DIP switch is used for changing direction and orientation. Left becomes right, and right becomes left. Or left becomes up and right becomes down. This is to accommodate different paddle orientations the games offer. So,
` you might need left/right or right/left or up/down or down/up.

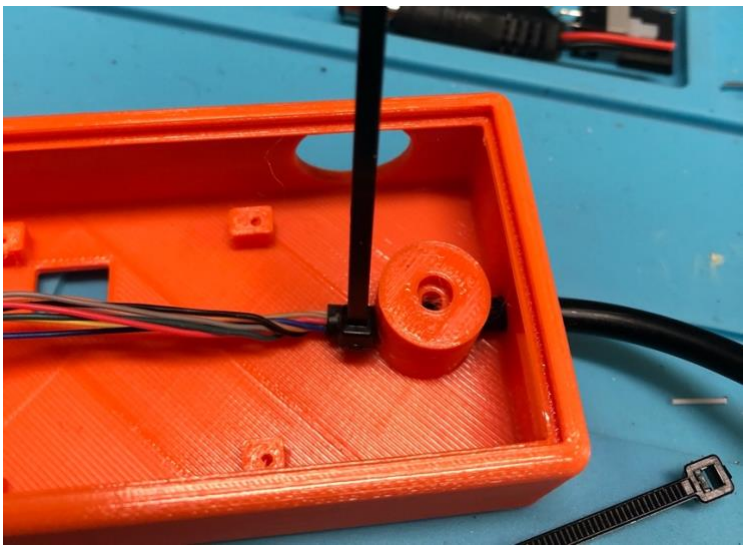
The Dip switch mounts to the back of the PCB. Mount it so the word ON is closest to the edge of the PCB.



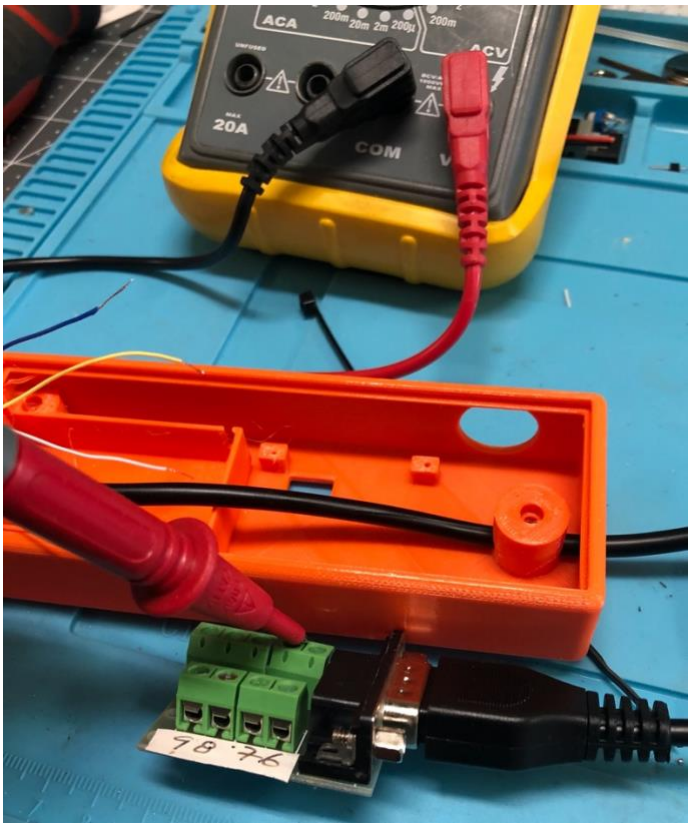
Connecting the Joystick cable

You've already prepared the joystick cable, now is the time to connect it to the PCB.

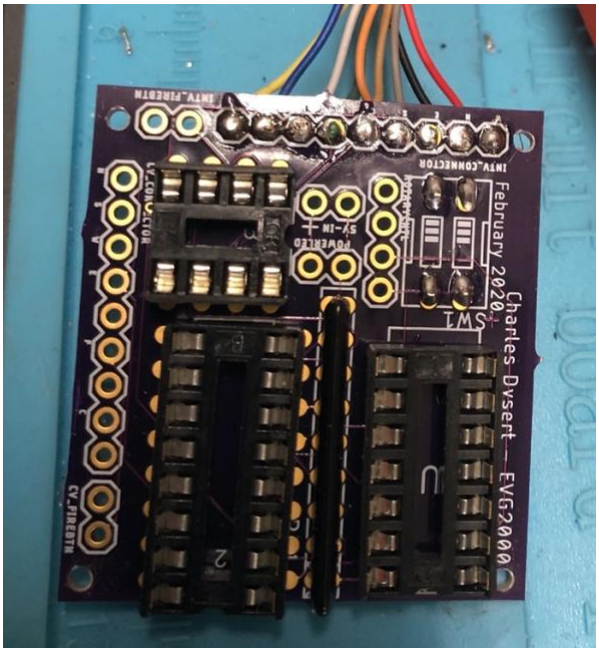
First thing to do is run the wire though the case and also through the hole in the screw mount. Depending on the JS cable you are using you may have to widen the hole. Place a zip tie on the cable to help protect the cable from being pulled and damaging the PCB connections. You will eventually add a zip tie on the other side of the screw mount, but for now we need to be able to pull the cable further.



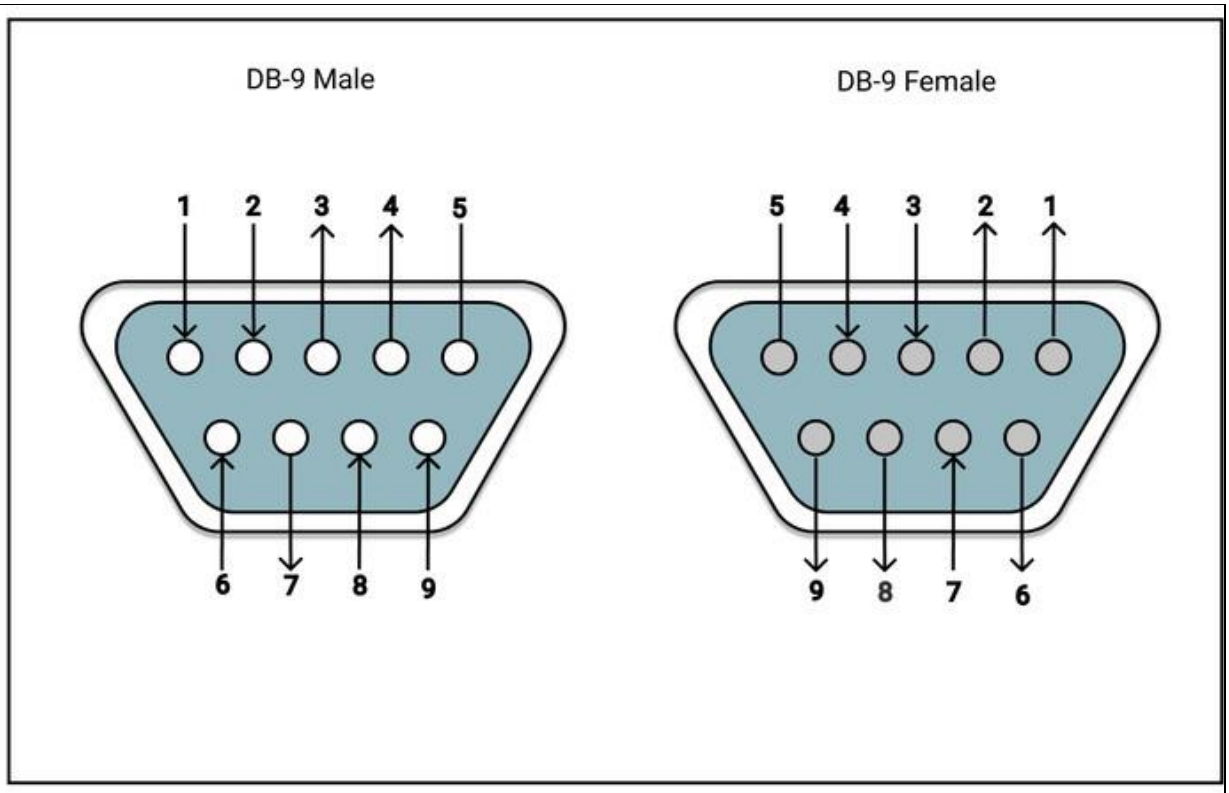
Part of this step will require identifying each wire to connect to the PCB. The PCB uses directions instead of numbers for the connections. Please use the information on the next page for determining each wire. Use the illustration for DB-9 Female.



The wires should be installed from the bottom of the board, solder the top side.



Joystick Wiring



Male – has Pins
Female - holes

Intellivision

Direction	Male	
C- Common	5	Brown
N - UP	2	Black
S – DOWN	4	Orange
E – RIGHT	3	Grey
W – LEFT	1	Red
F - FIRE	6 & 8	Green & Blue

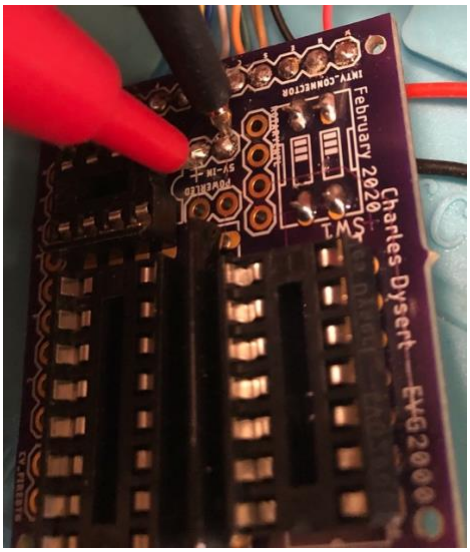
Colecovision

Direction	Male	
C- Common	8	Blue
N - UP	1	Red
S – DOWN	2	Black
E – RIGHT	4	Orange
W – LEFT	3	Grey
F - FIRE	6	Green

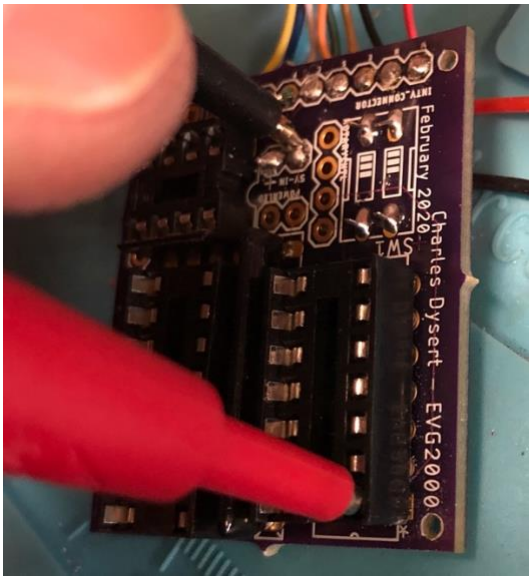
Install and connect the power switch.

The 9v connector and voltage regulator should fit through the power switch opening. If you used a different regulator and it doesn't fit, you will need to unsolder some wires to be able to install everything. The power switch should click in easily. The zero should be against the side of the case.

Connect the red lead to the positive connection, and negative to the – connection. The connections are next to U3, the bottom 2 connections. + on the right, - on the left. The wires should be installed from the bottom of the board, solder the top side. Once you have done this, connect a 9-volt battery and verify you have 5 volts at the connection when the switch is on, and 0 volts with the switch off.



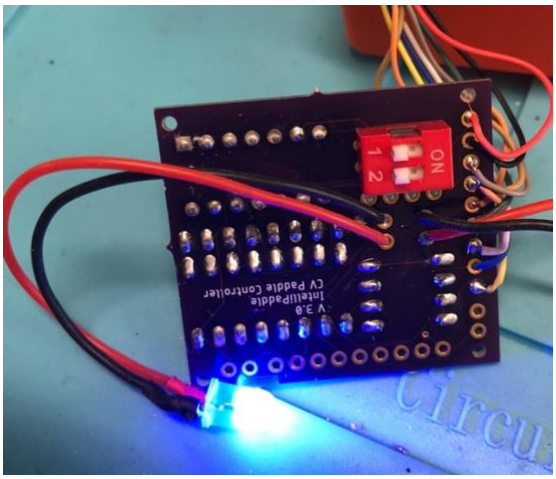
Next validate that you have 5 volts at pin 1 of U1, ATTiny84.



Connect the power LED.

Power led is connected above 5-volt in. The wires should be installed from the bottom of the board, solder the top side. You will eventually hot glue the LED into place. Once installed, attach the 9-volt battery and check that the LED lights when the

switch is on. If it doesn't verify that you have the LED connected properly, + to + - to -.

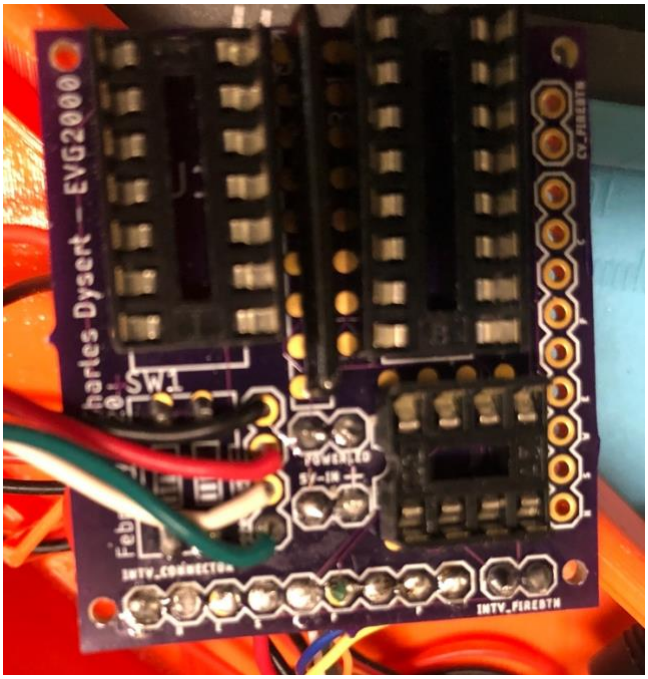


Connect the fire button

Install the button into the case. Don't use the washer, carefully attach the nut on the inside of the case. Make sure once tightened make sure the flat edge of the nut is up. Connect the wires to the proper connections, they are the two spots open next to where you connected the joystick cable. Doesn't matter which of the wires goes to which connection. The wires should be installed from the bottom of the board, solder the top side.

Connect the rotary controller

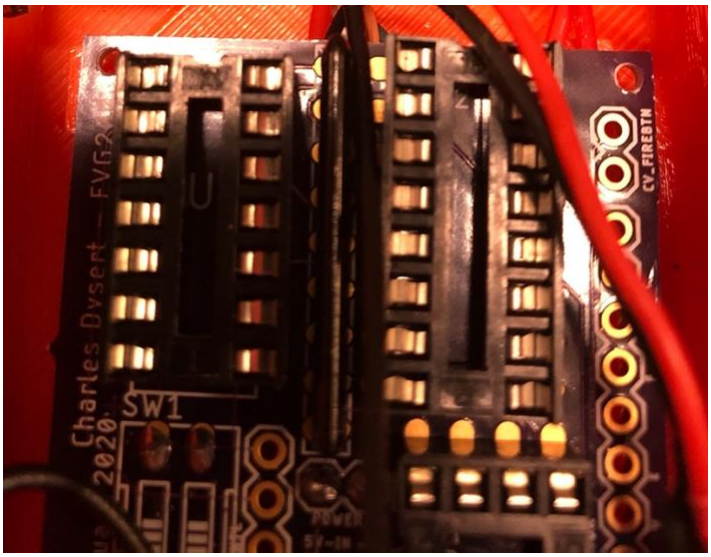
There are 4 wires to connect on the rotary controller, they will be installed from the top and soldered on the bottom. The connections are below U1. Starting at the connector closest to U1 they should be connected: Black, Red, White and the Green.



Congratulations! All of the wires are connected.

Now let's install everything into the case.

Carefully place the PCB into the case, make sure to line up the DIP through the hole in the bottom of the case. You should be able to screw the 4 2mm x 4mm screw to hold the PCB in place.



Next hot glue the voltage regulator to the side of the case. Since you already have the hot glue gun fired up, go ahead and glue the power LED into place. Insert the ATTiny84 and the OptoCoupler (s) into the proper location, with the correct orientation. Now would also be a good time to attach a zip tie on the other side of the screw mount to prevent the joystick cable from being pushed into the controller.

Go ahead an connect a 9-volt battery. Go ahead and carefully place the top back onto the controller. If you went with the top that uses screw to hold it down, insert them now. You can now place the proper placard into the top of the controller.

Before you go and play a game

Verify that the power switch still turns on the power LED.

I suggest that make sure the power to the console is turned off before plugging in or unplugging the controller. This is a good practice for any controller. This is not suggesting that the controller could damage your system, just a good precaution with older system.

Currently the orientation/direction switches require the power to be turned off and on for the change to take effect. I may update the software to allow the changes to happen without the power being turned off/on. Probably not a big deal.

Now go have fun!

Additional information

You can use a Y-connector with this design. I have a simple design on Oshpark you can use.

With this design, since the electronics are completely isolated from the system it can be incorporated into other devices such as an arcade controller. Just make sure the rest of the system properly isolates connection, such as the ColecoVision diode arry.