

PIG II Universal Shaker Motor work notes

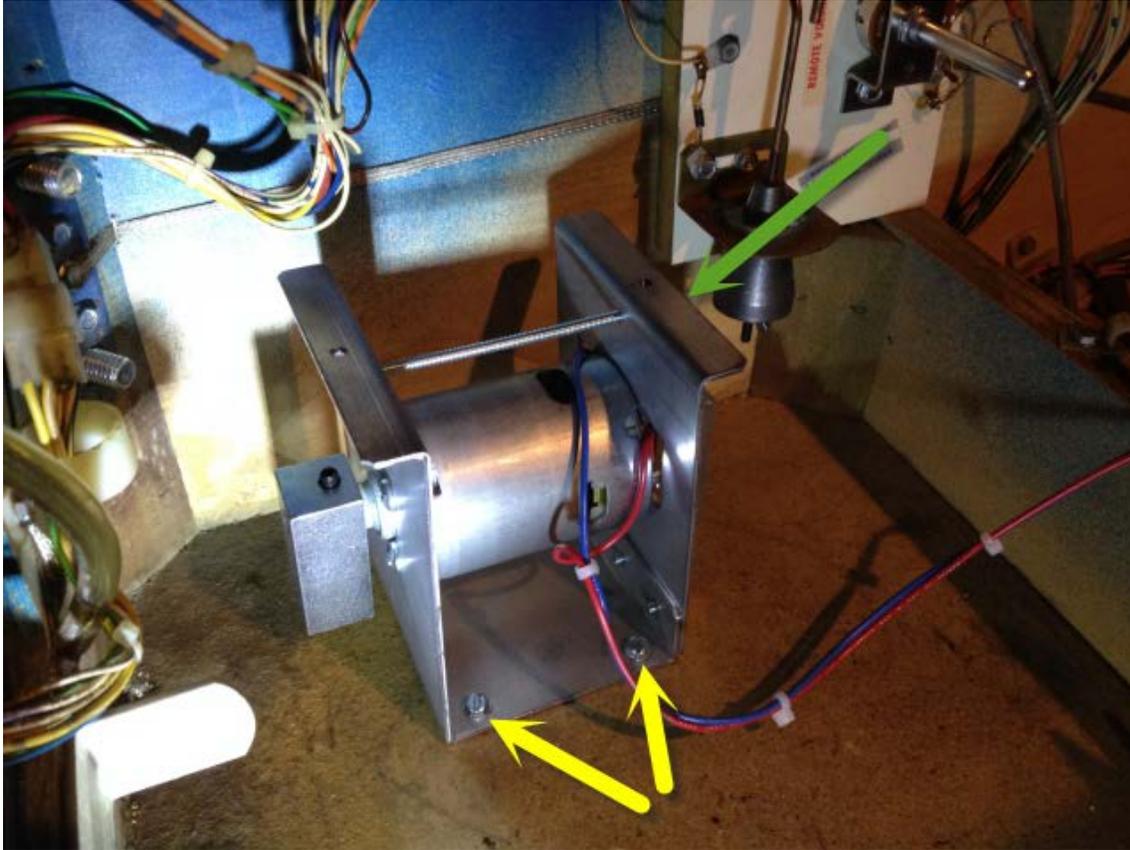
- Buy a shaker motor kit. I've been using the kit from Pinball Life.
 - o Parts Needed
 - Shaker Motor
 - Plastic safety cover
 - Mounting screws and T-nuts
 - o You will not need any included circuit boards or special connectors that came with the motor.
- PIG II and a DK Pinball connector pack
 - o Important note: If you're using a PIG 2 to control a shaker motor, that's all you can use it for. There are important reasons for this that I'll get into at the end of this document.
 - o If you have a good collection of .093 connectors and wires then you don't need the DK Pinball connector pack.
- Appropriate DK Pinball Power Tap
 - o This is to connect the PIG 2 to your games power supply cleanly. You can use the wires and connectors in the DK Pinball Connector Pack and tap right into your power wires if you're confident and don't mind cutting into wires.
 - o You'll have to replace the fuse on the power tap with a higher rated fuse. We're using a 3 amp fuse now. Start low if you can. I wouldn't exceed a 5 amp fuse.
- Replace the 2 amp fast blow fuse on the 12v line on the PIG 2 and replace it with a 3 amp slow blow fuse.
- 25v 15,000uf Capacitor – UVR1E153MRD6
 - o Occasionally we had game resets occur after the shaker was installed. The theory is that occasionally with the shaker firing up it would drop the game voltage below the lower limit on the 5v regulator. As a test we took a giant capacitor and connected it to PIG 2 to help smooth the voltage when the motor fires up. I picked 15,000uf because it was as big as I felt was reasonable. If we still had resets with a giant cap in place, then we'd have to find a better solution. So far, the cap has helped. We'll get a scope on the machine to see if we can get away with a smaller cap. The cap we used only costs about \$3 so we may just keep that size in case some machines require a bigger cap than others.
- Reed Switches
 - o <http://www.mouser.com/ProductDetail/Standex-Electronics/ORD213-10-15-AT/?qs=%2fha2pyFaduhdx3CYB6DCHLa8NFN%2fNGym0lbEbHyKil7pDjM9ateg%252bg%3d%3d>
- Drill and bits (The shaker installation instructions should explain everything you need to install the motor.)

Install the motor

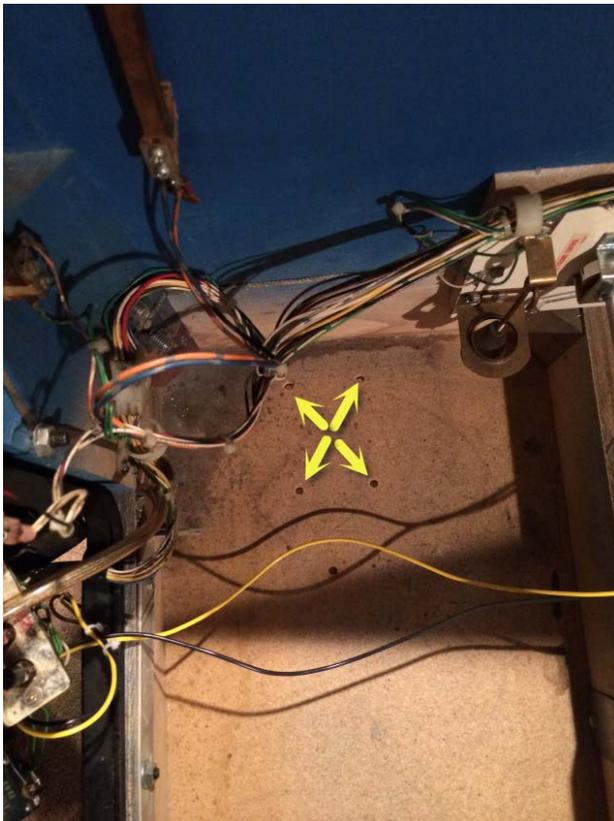
First cut off the connector to the wires on the motor. I don't think polarity matters. If you see clear indications of polarity, then make a note of it.

Crimp on a new 3 pin .093 connector. Use the ground (pointy end) and the 12v (flat side) holes on the connector. Leave the middle hole / pin empty. If there is a clearly marked positive and negative wire for the motor, make sure you connect (-) to ground and (+) to 12v.

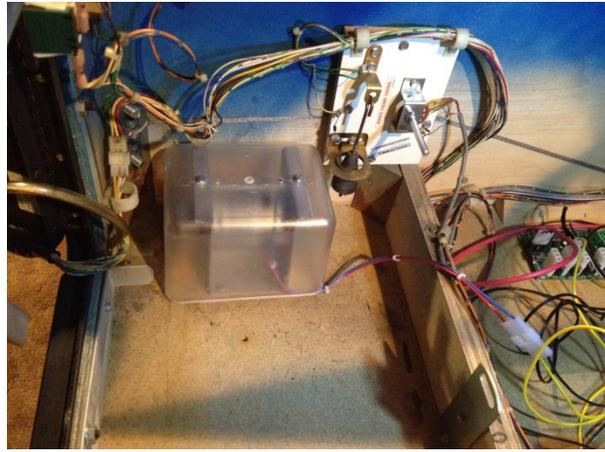
“Dry fit” the shaker in the cabinet. Do it with the plastic safety cover on. Most shakers are mounted right up at the front of the machine, in the left front corner, next to the coin box. I think this is so the shaker is as close to the hands of the player as possible.



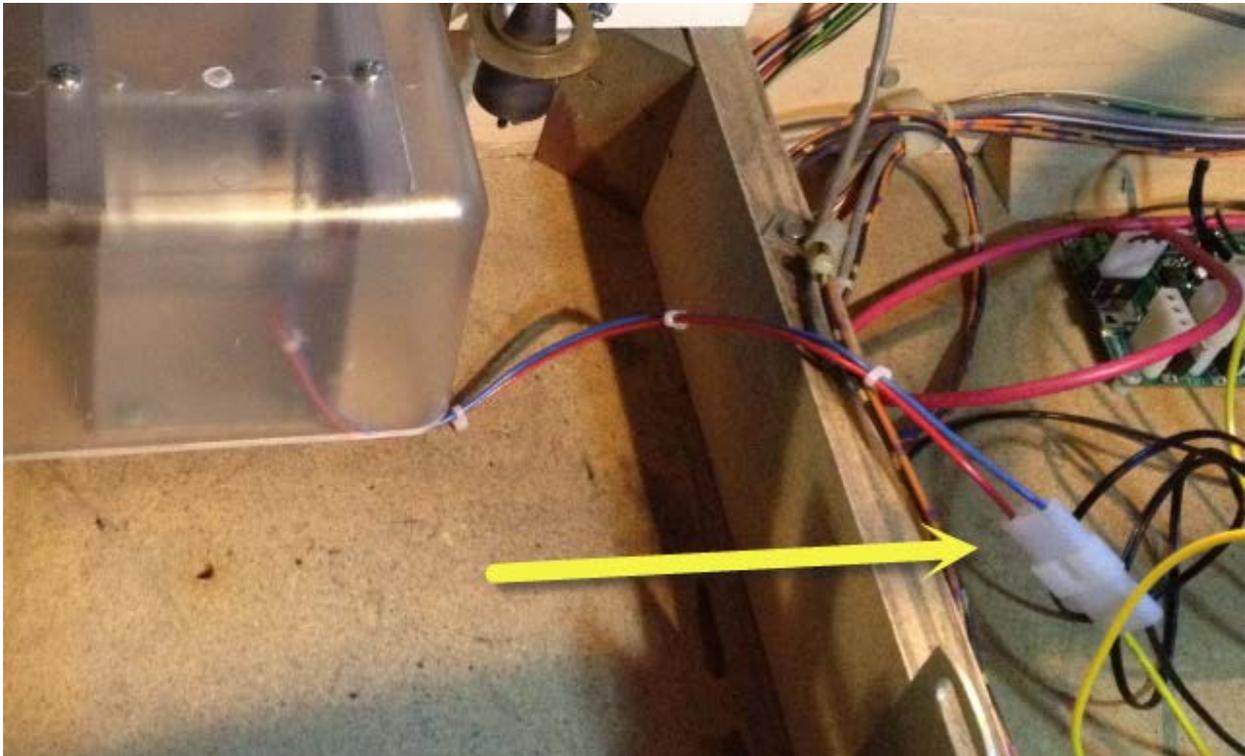
Once you have a good location picked, mark the holes and drill them out. The yellow arrows show two of the four mounting screws. Also, note the green arrow. On the motor we had, there is a screw that ties both sides of the mounting bracket together. Make certain this screw is tight. Our motor was really noisy and when we tightened this screw it completely silenced the rattling noise.



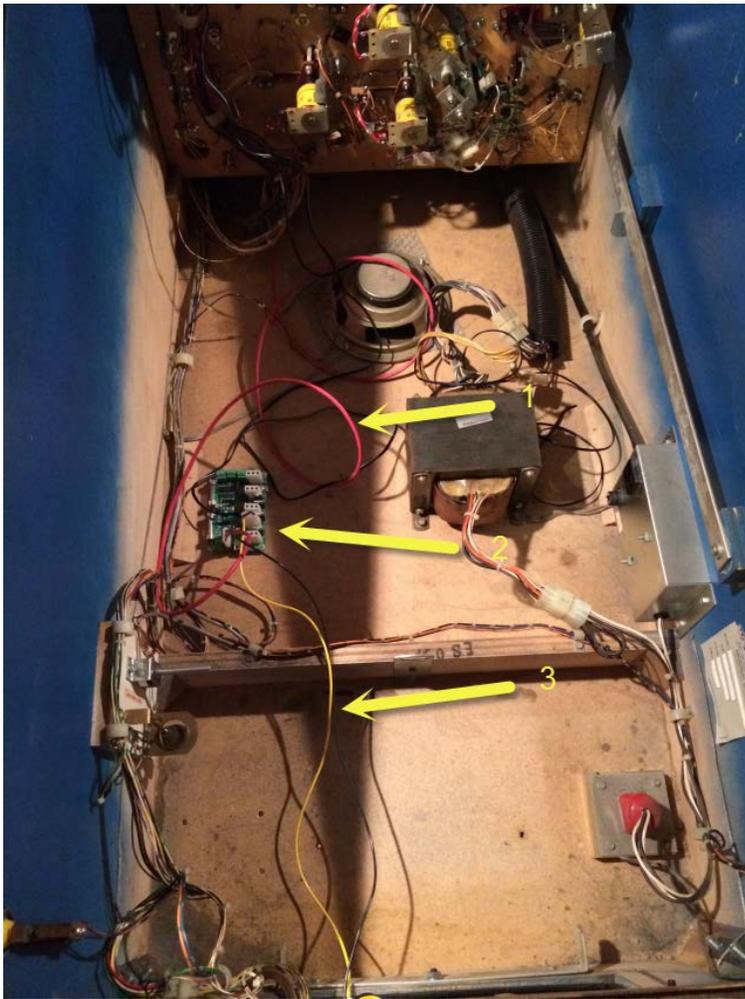
Holes drilled.



T-nuts tapped in and shaker motor mounted.



Note the new connector on the end of the shaker motor wires. It's connected to the PIG 2 with a little extension wire I made because the motor wires weren't quite close enough. It would have been best to mount the shaker motor, then the PIG 2 closer to it so you don't need the extension.



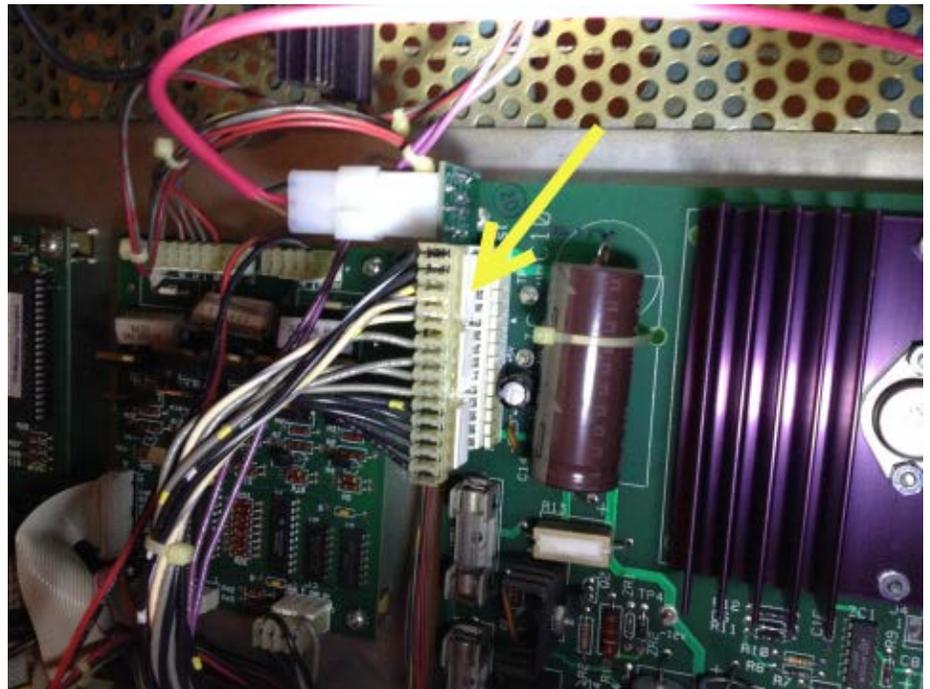
Mount the PIG 2

1 – Power cable running to back box.

2- PIG 2 screwed to cabinet bottom.
NOTE: Before you screw it down, connect it to the shaker motor wires and check for fit. I should have mounted this 4 inches closer to the front of the machine.

3 – This is an extension wire I made. At first we had the shaker mounted to a board outside of the game, just to make sure it worked before mounting it inside the game. You can do this if you want to test before permanently mounting anything to the inside of the cabinet.

Up in the back box, this is the power cable connected to the DK Pinball power tap on the power supply.

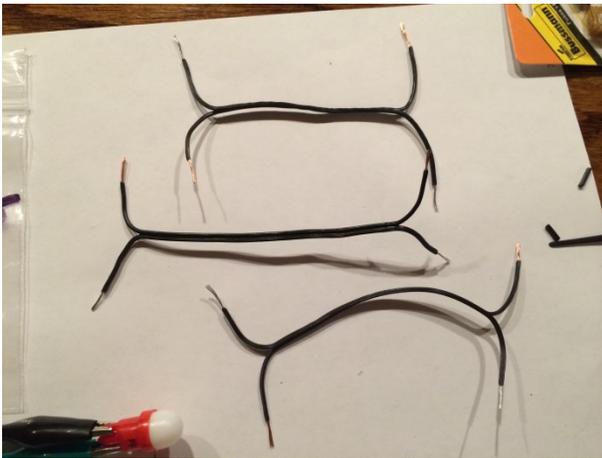


Connecting the PIG 2 inputs to the game

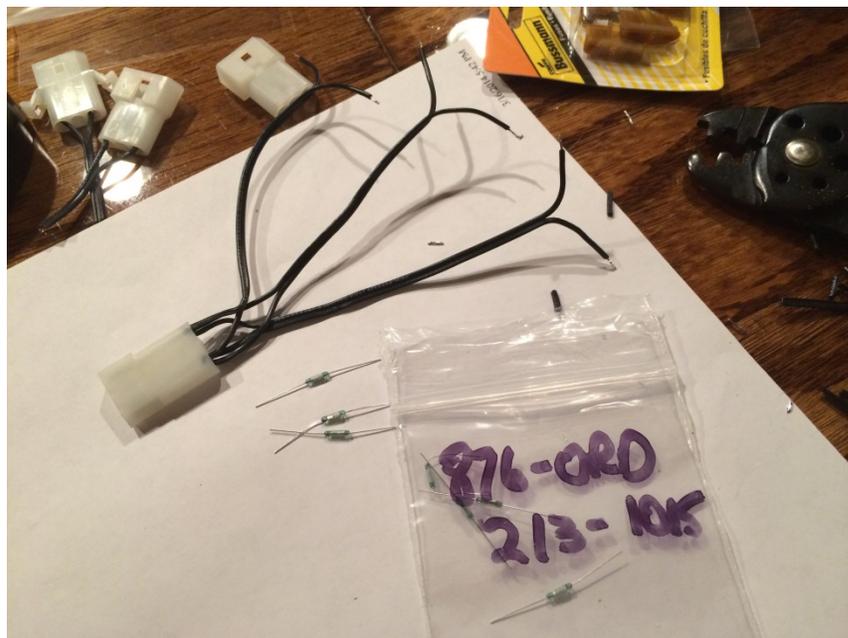
The game we're using here is a Whirlwind. Every game will have different things you'll want to use as signals to make the shaker motor rumble. What we chose here were the 6 pop bumpers, the "lightning" flashers at the back of the playfield, and the drop target flasher. We used two different ways to connect to the game.

This game has a lot of pop bumpers. For coils I recommend using a reed switch (Part # 876-ORD213-1015 from Mouser.com). The first reason to use the reed switch is it better isolates the PIG 2 from the games "high power". The PIG 2 can handle 24 volts, but that's the upper limit. A reed switch will still register when a coil is fired without taking any chances that you'll blow up a PIG 2 input.

Another reason to use reed switches, especially on pop bumpers, is that they save inputs. If you wire them in parallel, you can use as many reed switches as you want to trigger a single input. Input 5 and 6 (the aux input) is built specifically for this purpose. On this game, we use 6 different pop bumpers and only 1 input on the PIG 2.

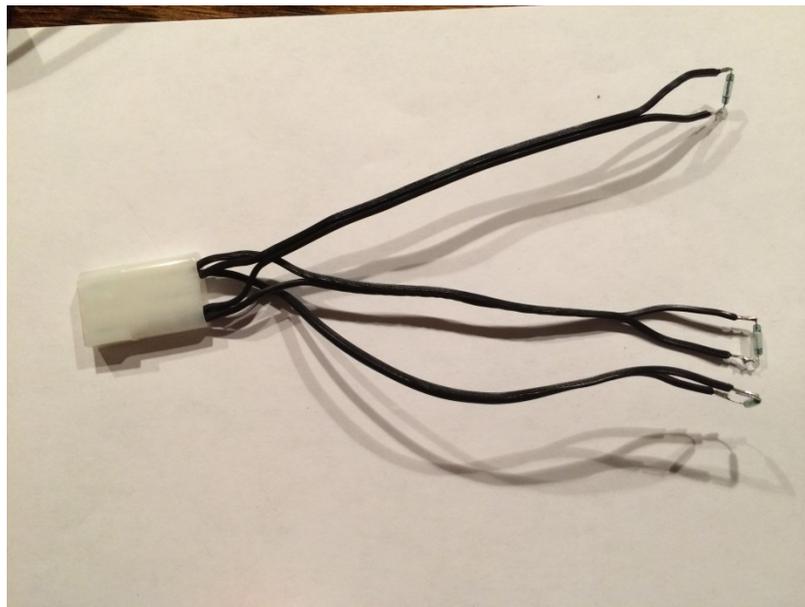


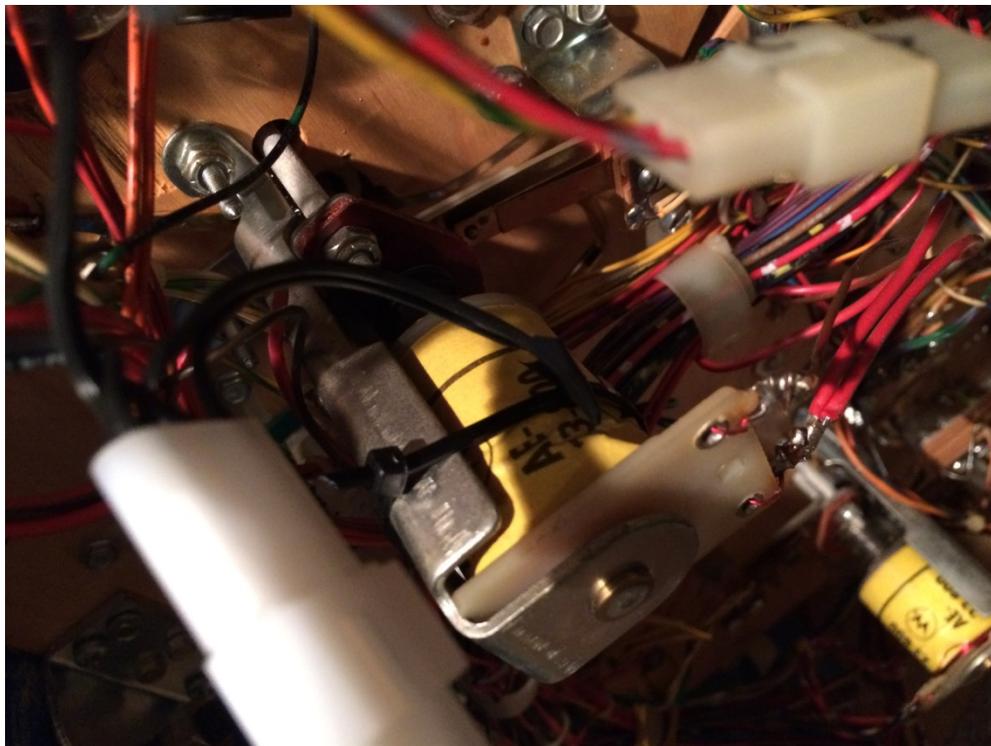
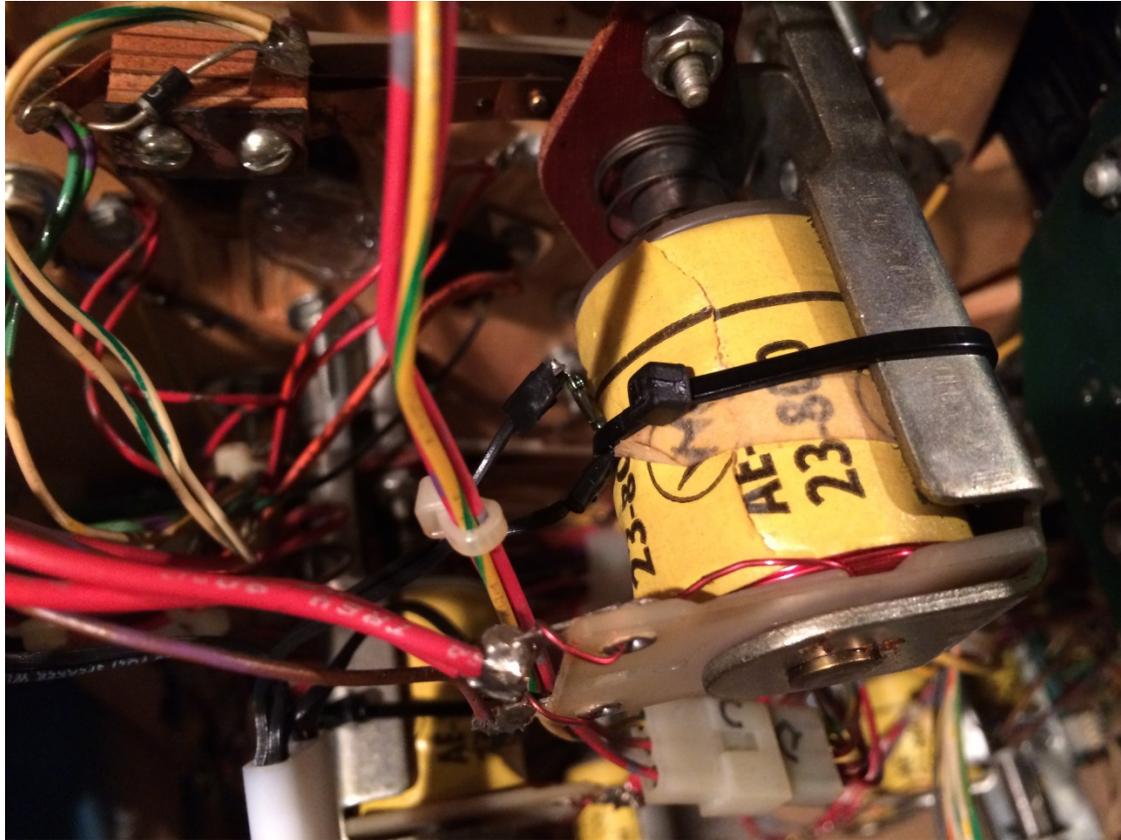
On this game I connected 2 sets of 3 reed switches to a quick disconnect connector, then zip strapped the reed switches to the outside of the coils. Each wire was about 4" long.

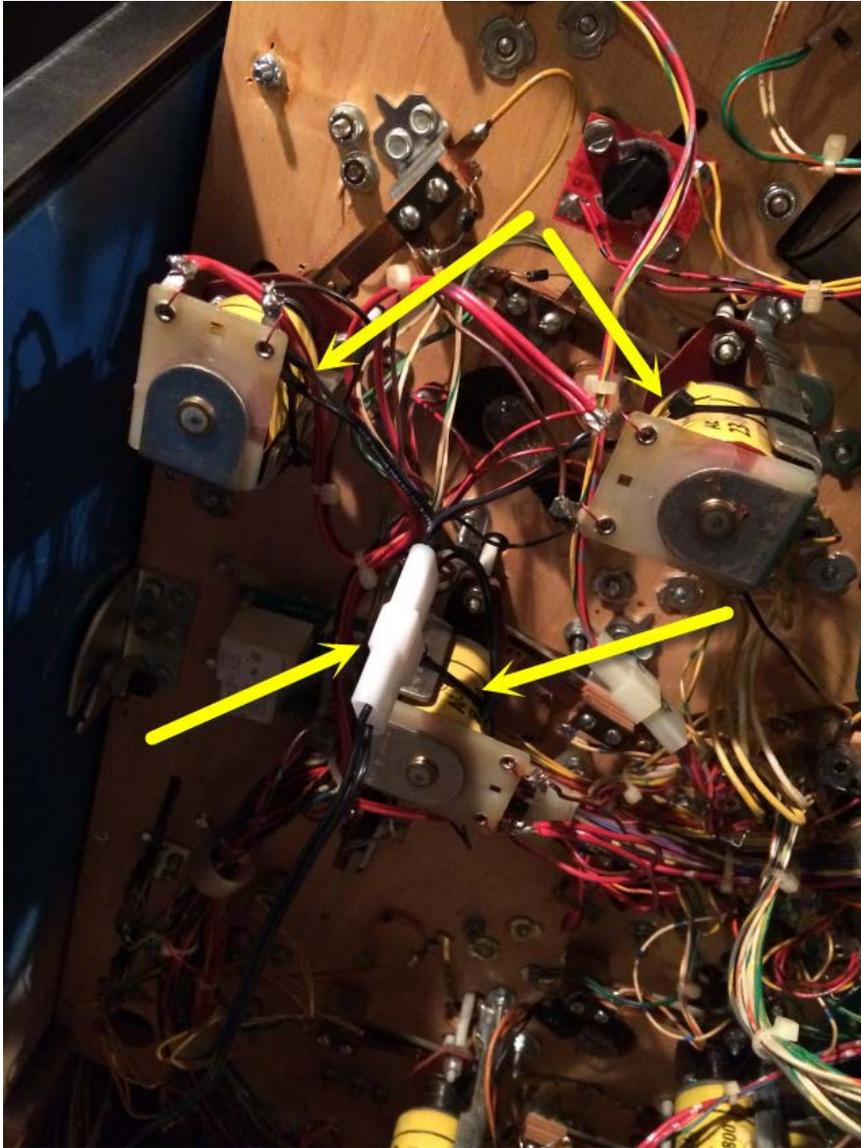




Here is what the reed switches look like with the leads trimmed. I make them nice and short to reduce the chance of them shorting on anything. A reed switch is basically a leaf switch encased in glass that closes when it's in proximity to a magnetic field. Coils are electromagnets.





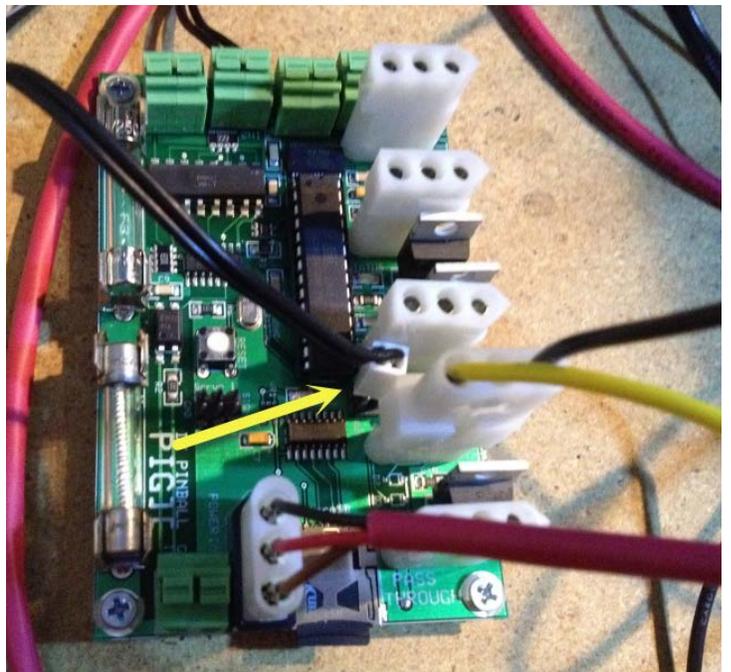


Here you can see everything connected. Three pop bumpers.

I then created a "Y" cable to do the same thing on the upper pop bumpers. They all reduced down to a single pair of wires that plug into the .100 "AUX" connector on the PIC 2.

The yellow arrow points to the AUX connector.

6 Pop bumpers connected to a single input.



Flashers

On Whirlwind there are flashers that represent lightning and a thunderclap that sounds when they flash. This was perfect for a shaker. We removed the back panel from the playfield and identified the flasher. As it turns out, there are three flashers that all connect in parallel to the same connector.



I soldered a connector wire to the back of the 6 pin header, used a zip strap to connect the wire to a post as stress relief, and then ran the wire down to input 2 on the PIG 2.



Last, using alligator clips, I connected the "drop target flasher" to Input 3 on the PIG 2.

The Capacitor

As I said in the notes at the top, we had a problem with the game occasionally resetting. Just going with a gut feeling, my guess is that occasionally, with everything going at once and the shaker firing up, there is a momentary voltage drop on the 12v line.

According to the datasheet on the 5v regulator on the power supply, if the 12v line drops below 9v, the 5v regulator drops out. The shaker motor draws the most power when it is first starting up. As it comes up to speed, the power draw drops. Imagine how hard you have to pedal a bike from a stop to get it moving. Once you're at speed, you don't have to pedal as hard.

To deal with that voltage drop, I added a large cap to the PIG 2. Luckily, this is really easy to do.



I just soldered .093 pins to a 25v 15,000uf capacitor and snapped them into a plug – making certain to have the negative side of the capacitor connected to the ground pin.



Then you just plug it in to the “Through” on the PIG 2 and you're set. We played for hours without a reset.

PIG.TXT configuration

I will continue to add configuration examples at http://dkpinball.com/wiki/index.php?title=Pig_2

Part of the fun of doing this particular mod is playing around with the configuration settings to get interesting feedback from the shaker motor. Depending on what game you have, you may want different effects.

Some will be pretty much the same game to game. Pop bumpers set to MaxOUT# = 255 and a noInterruptOUT# set to 75 (75ms) will probably feel right in most games.

Here are the changes we made to the PIG 2 configuration file for the Whirlwind with explanations.

Pop Bumper

First, because Input 5 (AUX 1) is a switch, we need to invert the input. Then we map IN5 to OUT1.

INPUT 5 (AUX)

```
invertIN5      = 1
mapIN5-OUT1    = 1
mapIN5-OUT2    = 0
mapIN5-OUT3    = 0
mapIN5-OUT4    = 0
bufferIN5      = 10
```

Then we configure OUT 1 to be a short 75ms "JAB" of full power.

OUTPUT 1

```
powerMaxOUT1   = 254
powerMinOUT1   = 0
fadeOn1        = 0
fadeOff1       = 0
delayOn1       = 0
delayOff1      = 0
andOUT1        = 0
mapGI1         = 0
noInterruptOUT1 = 75
invertOUT1     = 0
repeatOUT1     = 0
repeatDelayOUT1 = 0
repeatDecayOUT1 = 0
repeatResetOUT1 = 0
```

Flasher 1 Lightning – Rolling thunder

We're using IN2 which is mapped to OUT2 by default. So no changes need to happen on IN2.

The output, we want to mimic rolling thunder. This is where experimenting is required to get the desired effect. You're best off playing with Time first, then strength. In this case we came up with a max output power of 100 and then we fade off over 1 second (1000ms)

OUTPUT 2

powerMaxOUT2	= 100
powerMinOUT2	= 0
fadeOn2	= 0
fadeOff2	= 1000
delayOn2	= 0
delayOff2	= 0
andOUT2	= 0
mapGI2	= 0
noInterruptOUT2	= 0
invertOUT2	= 0
repeatOUT2	= 0
repeatDelayOUT2	= 0
repeatDecayOUT2	= 0
repeatResetOUT2	= 0

Drop Target Flasher

This particular flasher flickers, so we stayed with a quick jab, much like the pop bumper. The effect works really well. We use IN3 which is mapped to OUT3 by default, so there is no change. Also, it is a lamp so there is no need to alter the input.

OUTPUT 3

powerMaxOUT3	= 254
powerMinOUT3	= 0
fadeOn3	= 0
fadeOff3	= 0
delayOn3	= 0
delayOff3	= 0
andOUT3	= 0
mapGI3	= 0
noInterruptOUT3	= 75
invertOUT3	= 0
repeatOUT3	= 0
repeatDelayOUT3	= 0
repeatDecayOUT3	= 0
repeatResetOUT3	= 0

Appendix A – If using a PIG 2 as a shaker controller, you can't use it for anything else – why?

Three reasons

- PWM Whine
- Redirected outputs
- Power pulses on outputs
-

First and foremost – PWM Whine. We're controlling the speed of the motor using Pulse Width Modulation. Here is a video explaining PWM if you're not familiar with it: http://youtu.be/Y1QraI5i_XM

The problem is, you can use PWM at different frequencies. The default frequency for the Atmel chip we're using is around 500mhz. At this frequency, at low speeds, the motor emits an audible whine (It's roughly a middle "B" on a piano). In order to make this whine go away, we need to mess with the timers on the chip to drop the tone to a level where it can't be heard.

When we change the timers on the chip, the shaker works great, but the other outputs get thrown out of whack. LEDs pulse funny and just don't look right.

Next, in order to have different inputs create different effects on a single output, programming changes needed to be made. In "Shaker Mode", you configure each output (1 through 4) with different effects. But each output is re-directed to Out 1.

Last, that shaker motor, when it's first starting to turn draws a lot of power. So much that if you had other mods connected, you would see pulsing and flickering on those mods. It doesn't look very good.