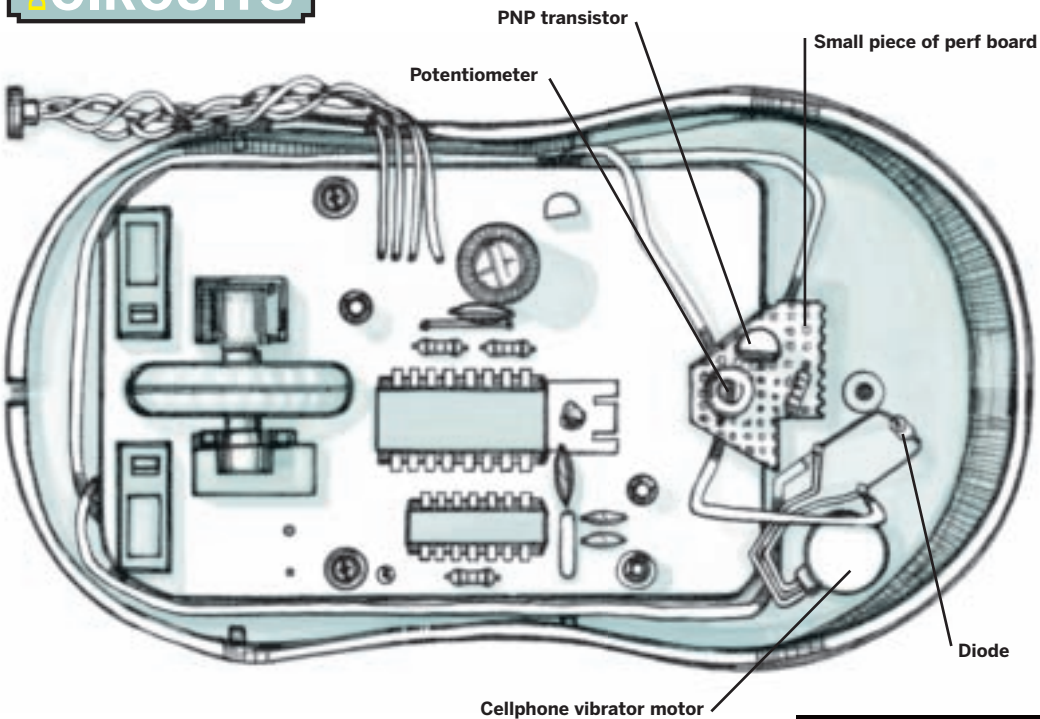


Inside the completed rumble mouse. Note the diode that is soldered in parallel with the motor.

RUMBLE MOUSE

For FPS gaming, a cellphone vibrator gives kick to your clicks.

By Greg Lipscomb

Have you ever been playing your favorite first-person shooter with someone's rumble controller and thought, "I would love to have that capability while playing on my computer"? A friend of mine had a spare rumble pack lying around, so he decided to stick it in a mouse. This inspired me to create my own version.

I determined that my rumble mouse should meet certain specifications. I wanted it to be fully enclosed, with no parts sticking out of the case. It should be an optical mouse, rather than a roller-ball one, connected and powered by USB. In play, the mouse would give a satisfying rumble-recoil when you click the left button — the trigger in most FPS (first-person shooter) games.

I found a cheap suitable mouse from a local surplus store. It had a scroll wheel that I liked, and was large enough to fit the extra components inside. For the rumble motor, I wanted something small, and my fiancée suggested that I use a cellphone vibrator. I had several old cellphones lying around, so I cut one open and located its small motor near the top left corner, which looks like a watch battery with two wires coming out of it.

Naturally, different phones are different. Nokias I've cracked open use small cylindrical motors, not as flat, and in an old flip phone I took apart, the motor was in the same piece as the speaker, close to the LCD screen.

Illustration by Damien Scogin

Figure 1

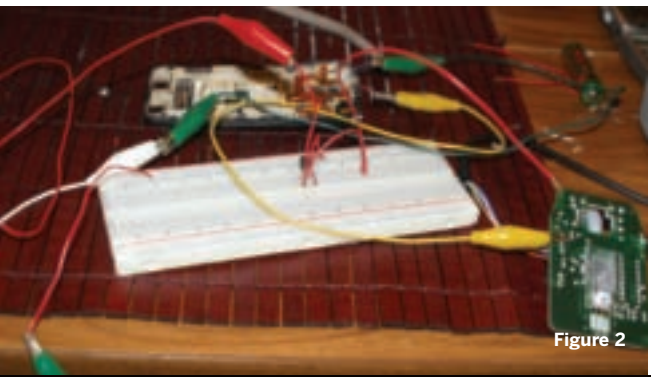


Figure 2

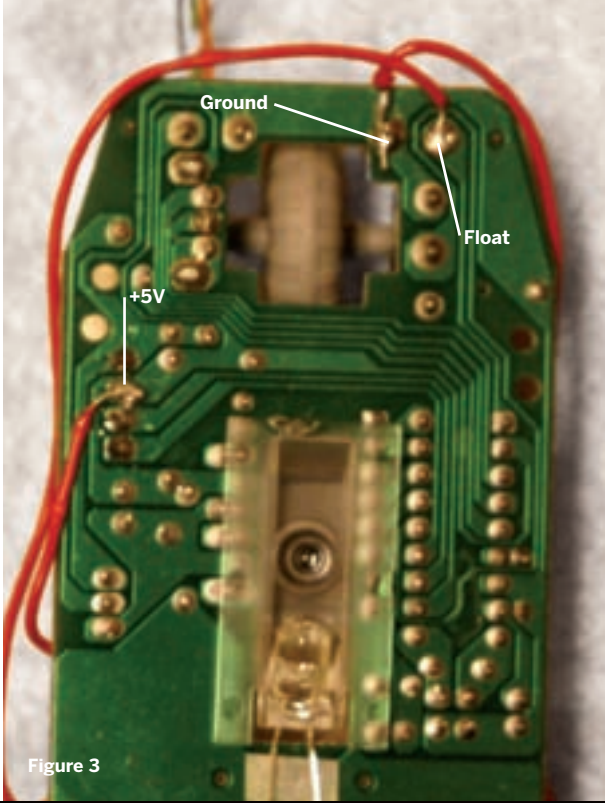


Figure 3

For the rumble motor, I opened up an old cellphone and dug out the vibrator, which looks like a thick watch battery (Figure 1). Bench test for the rumble mouse circuit on a solderless breadboard (Figure 2).

The three pins used in the circuit: +5V is direct from the USB cable, Ground is common ground for the circuit, and Float is the pin that momentarily grounds when you click the left mouse button (Figure 3).

MATERIALS

- **Optical USB mouse** I used an off-brand, model HTM-67WT
- **PNP transistor, 2N3906** RadioShack #276-1604
- **Electric vibrating motor** Salvage from cellphone, or use Sanko Electric #1E120, available at allelectronics.com, catalog #VB-1
- **5kΩ or 1kΩ micro trim potentiometer** A 10kΩ pot, like RadioShack #271-282, works, but lower values fit the adjusting range better
- **Diode, 1N4001**
- **1kΩ resistor**
- **Mini perfboard** RadioShack #276-0148

I also needed a switch to connect the USB power to the motor when the left mouse button clicks. I chose a PNP transistor for this. The final mandatory part was a 10kΩ potentiometer, which would be used to regulate the current going to the motor.

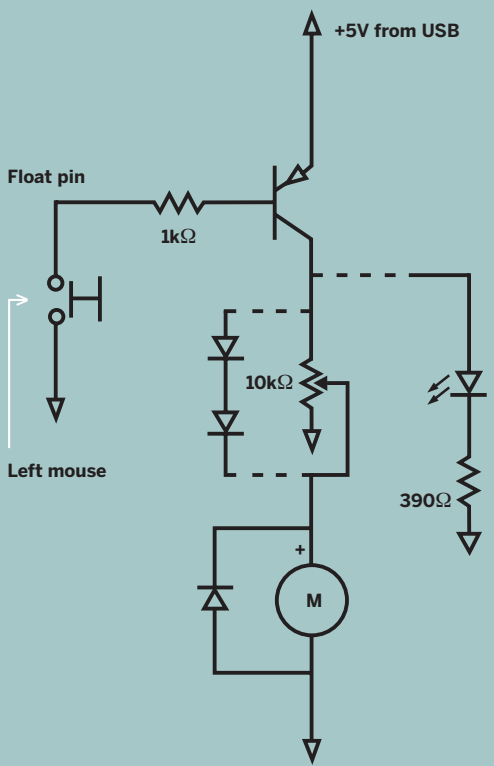
Find and Adjust the Power

The rumble circuit takes power from the USB port and directs it to the motor, so I needed to find +5V power and ground contacts both on the USB cable and inside the mouse. For the cable, I found a USB pin-out diagram of a USB cable online, and learned that the two outer pins of the USB cable are the +5V and the ground. Then I opened up the mouse and used a digital multimeter to probe for terminals on the board that connected to the USB's power and ground pins. On my mouse, I found that the green wire from the USB was ground, and the blue wire was the +5V. Then I connected the cellphone vibrator directly to the USB power, just to make sure that it could pull enough power to run. It worked perfectly.

I soldered jumper wires to the +5V and ground contacts on the phone, and started putting my circuit together on a solderless breadboard. The vibrator motor had a labeled rating of 3.6V, so I needed a resistor in series with the motor to lower the incoming voltage from 5V. I chose to use a 10k potentiometer, which would let me adjust the voltage and therefore the speed of the motor. You can use your multimeter to make sure that the voltage across the motor is less than 3.6V.

An alternative to the potentiometer is to use two diodes in series. Each diode drops the voltage 0.7V, so if you have two, you would drop 1.4V to give 3.6V over to the motor. Either way, it's important to have a separate diode in parallel with the motor. When the transistor is first activated, the

Photography and illustration by Greg Lipscomb



Rumble mouse schematic (optional circuitry shown by dotted lines). Note that the potentiometer can be replaced with two diodes in series, as shown. There is also an optional LED-resistor subcircuit that lights when the left mouse button is clicked.

motor voltage can spike really high, and a diode will protect the transistor from this high-voltage spike.

Intercept the Left-Click

The next step was to locate the board contacts for the mouse's left-click button. It was a single-pole momentary switch, and using my multimeter, I found which pin was ground and which pin was floating. I soldered a jumper wire to the floating pin contact, and continued breadboarding. Since the mouse button operates by grounding the floating pin, I needed an electrical switch that would be activated by a low voltage signal. A PNP transistor was perfect for this requirement. Connect the float pin contact to the base of the transistor, and low voltage from a click action completes the circuit between the emitter (connected to power) and the collector (connected to the motor). Note that this is opposite from an NPN transistor, which is open with a high base current. (Another approach would be to forget the transistor and just hook the motor up between +5V and the floating pin. Then, while the floating pin is grounded, 5V runs through the motor to ground.)

To limit the current flowing through the transistor base, I put a 1k resistor between the floating pin and the transistor base. Then I connected the emitter of the transistor to my +5V from the USB port, and connected the collector of my transistor to the motor through the 10k potentiometer. The other pole of the potentiometer was connected to ground. (When wiring a potentiometer, it is important to attach one wire to the middle pin, and place the other wire on either of the two outer pins. If you connect to both outer pins, you will always get the total 10kΩ.) This completed my circuit on the solderless test board, so I tested it and fixed the bugs.

Put It Together

The final step of my project was to solder everything together. I soldered my components to a small piece of perfboard, using small wires to connect the appropriate leads. Then I used double-sided tape to connect the motor to the casing at the back of the mouse. I also routed the wires to fit nicely into the body of the mouse.

When I completed the assembly, I had a fully functioning rumble mouse that would vibrate on every left mouse click. It is perfect for any first-person shooter game.

Some ideas for improvement would be to add a simple toggle switch between the +5V from the USB and the emitter of the transistor so that the rumble part can be turned off. All in all, this is a straightforward DIY project that is sure to enhance your gaming experience.

Greg Lipscomb is an electrical engineer (Auburn University) who is in his second year of medical school at the University of South Alabama in Mobile. You can see his work at diylive.net.