MAKE A HIGH-RESOLUTION OPTICAL ROTARY ENCODER FROM A COMPUTER MOUSE

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As microprocessors infiltrate every aspect of ham radio, there is a need for high resolution encoders to allow digital input by rotating a control. The most common application would be the main tuning knob of a radio but any input where the user completes a feed back loop is an excellent candidate for a rotary encoder, such as level adjustments, CW keyer parameters and menu selection. Commercially available encoders range from $20 to more than $100 and the price is loosely proportional to the resolution and optical units are more expensive than mechanical contacting units. This article described how to use the components of a computer mouse and an inexpensive potentiometer to make an optical rotary encoder with a resolution of 100 pulses per revolution (depending on the computer mouse).

A detailed description of the theory of quadrature endcoding is beyond the scope of this article. Basically a rotary encoder has two outputs, A and B, that are offset in time as the shaft rotates so a microprocessor can determine the direction and amount of rotation applied to the encoder. Figure 1 shows the expected voltage wave forms as the encoder is turned.

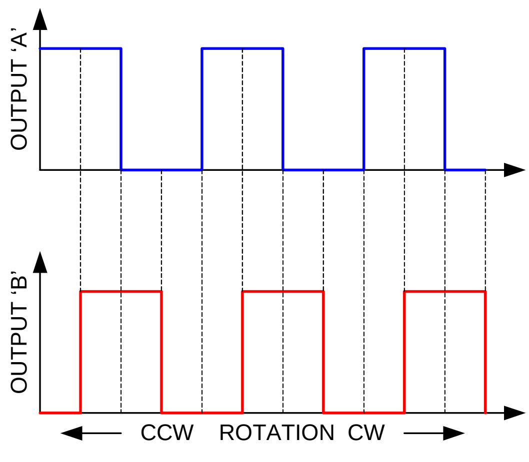

Figure 1: Rotary encoder waverforms.

First find an old computer mouse with a ball on the bottom, the new optical style won't work. Disasseble the mouse and expose the circuit board. Figure 2 shows the inside of a typical mouse with a rectangle around the useful pieces.

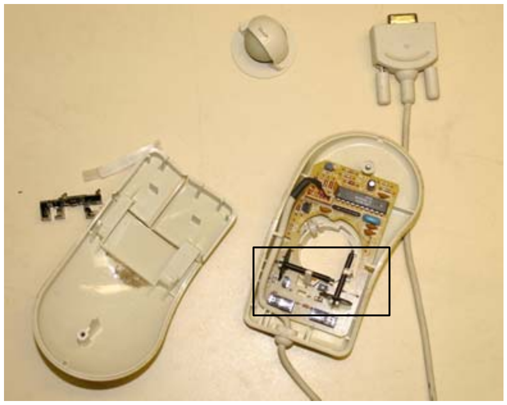

Figure 2: Disassembled computer mouse

You'll need to remove the light source, photo diodes and the chopper. There are two of each of these in every mouse so you'll have a back-up. Figure 3 identifies the components to remove from the mouse.

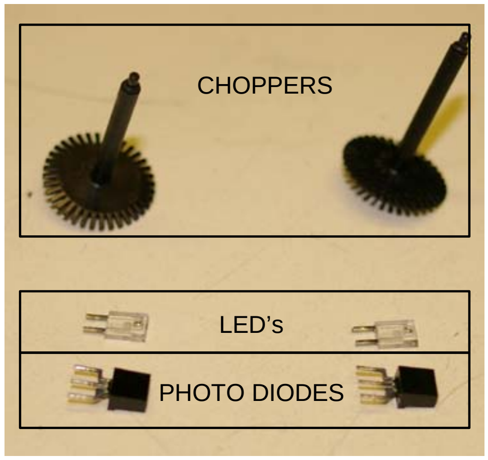

Figure 3: Components removed from the mouse.

Then carefully pry the cover off of the potentiometer, you'll have to reassemble it after the modifications are made. Figure 4 shows the potentiometer with the cover removed.

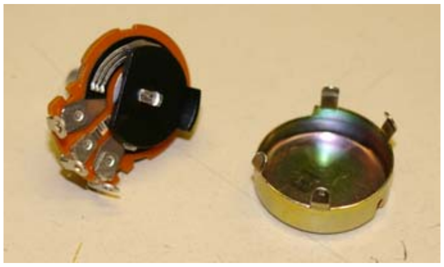

Figure 4: Potentiometer with cover removed.

Then remove the wiper and resistive element. Trim the terminals to allow connections to the photodiode. Figure 5 shows the prepared potentiometer.

Figure 5: Potertiometer ready for photodiode and chopper.

At this point the shaft will fall out of the potentiometer so we have to make a stopper to hold the shaft in. Drill a hole in a piece small of PCB material so the PCB material fits tightly on the back of the shaft. The shaft has a small dent in the center from when the pot was originally pressed together. Drill this dent making it large enough to accept the chopper. Then trim the outside of the PCB material with cutters and file it round. The PCB material should look like a washer when it is completed. Solder the left hand lead of a photo diode to the left hand terminal. Align the diode so that a line drawn through the center of the shaft passes through the center of the photodiode as shown in figure 6.

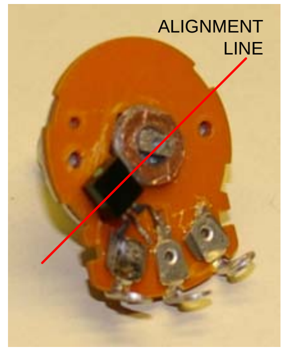

Figure 6: Mounter stopper and photodiode.

Then connect the remaining leads of the photodiode to the other two terminals on the potentiometer as shown on Figure 7.

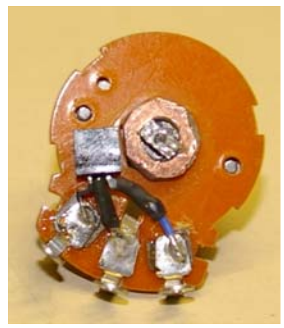

Figure 7: Photo diode connections.

Mount the chopper on the end of the shaft as shown in figure 8. I recommend two part, 10 minute epoxy over single part instant glue for strength and consistency.

Figure 8: Installed chopper.

Drill a hole in the potentiometer directly over the photodiode, cutoff the extra shaft on the chopper and reinstall the cover. Use more two part epoxy to mount the LED to the back of the potentiometer shining into the hole in the cover, through the chopper and into the photodiode. The LED and photodiodes operate in the infrared range so none of the light is visible.

The encoder is now ready to install in a circuit Figure 9 shows how to connect the encoder in a 5 volt logic circuit. Some adjustment of the resistor values may be necessary due to variations in components found in different mousse (mice).

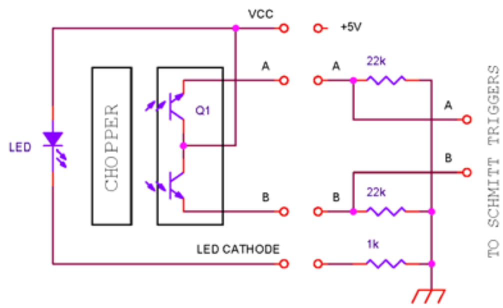

Figure 9: Hook-up Diagram.

I have found that the positioning is not too critical and that even if the quadrature signals aren't perfectly centered, the microprocessor never misses a pulse.