

# Build a Crystal Radio!

## A Cub/ Scout Craft

by Don Tolson

**T**hink back to your past...do you remember the crystal radios you used to make when you were young? Our Cubs had a ball making their own, working radios as a way to wind up a section on Morse Code and Radios. Their contagious excitement brought back more than a few happy memories for me, too!

Quite a bit of preparation is required to make this work smoothly, and you should think about setting aside at least an hour and a half (maybe in two sessions) to complete this activity.

The original circuit diagrams for the radios are from [http://journeytoforever.org/edu\\_xtal/PLANS.HTM](http://journeytoforever.org/edu_xtal/PLANS.HTM), and I thank them from the bottom of my heart for posting these. This site also provides addresses for getting some of the harder-to-find components, if a local supplier can't help you.

### Materials: (for each radio)

#### Base Construction:

- One 6" x 6" x 3/4" pine board
- One #5 x 5/8" Robertson wood screw + washer
- One medium-sized (approx. one inch long) trombone-type paper clip
- One cardboard toilet paper roll
- Four one-inch bright common nails
- 1 piece (approx three inches square) of 280 or 320 grit sandpaper

#### Electrical Components:

- Approximately 660 inches of #28 enamel coated magnet wire (sometimes sold in spools)

- Crystal Earphone (Mode Electronics #70-265-1)
- #22 hookup wire (Radio Shack sells a spool as #278-1296)
- Generic Germanium Diode (1N34 or equivalent)
- 47K ohm resistor
- 3.5 mm phone jack (for the earphone to plug into)
- 'Mini' alligator clips (for the end of the ground wire)

**Note: The only 'critical' components are the Crystal Earphone and the Germanium Diode.** Do not substitute a silicon diode, since it won't produce enough signal. The same goes for the earphone – only the Crystal Earphones have the sensitivity required to pick up the signals.

#### Tools Needed:

- Soldering Iron/Gun and solder (used by the leader)
- Hot glue gun (used by the leader)
- Hammer
- Screwdriver
- Scissors
- Needle-nosed pliers

#### Pre-craft Preparatory Work:

To keep the craft moving along at a reasonable pace for Cubs, and reduce the amount of 'waiting time' for soldering, etc., there a number of assemblies which are best pre-constructed.

#### 1. Wood base:

I bought pine shelving and cut it down to the appropriate size using the table saw. Then, I pre-marked the

spots where the nails (which are used as connection points) should be hammered in. The positions aren't crucial – just so there is enough room for the coil and the nails are close enough together for the resistor and the diode to be attached. Below is a template you can use.

You don't have to mark the 'Coil goes here' box – it's for later. I've numbered the nail sites (the circles) for convenience in the instructions below. You can put the numbers in, or not, as you prefer (I didn't need them when I did it with my Pack). I left the nails out at this point, preferring to let the Cubs do this as their first part of the activity.

#### 2. Antenna Wire:

This is a 10 foot length of the #22 hookup wire, with about 3/4 inch of insulation taken off one end.

#### 3. Earphone Jack:

Solder two pieces of hookup wire, approximately four inches in length, to the appropriate terminals on the jack, and strip about 3/4 inch of insulation off the other ends.

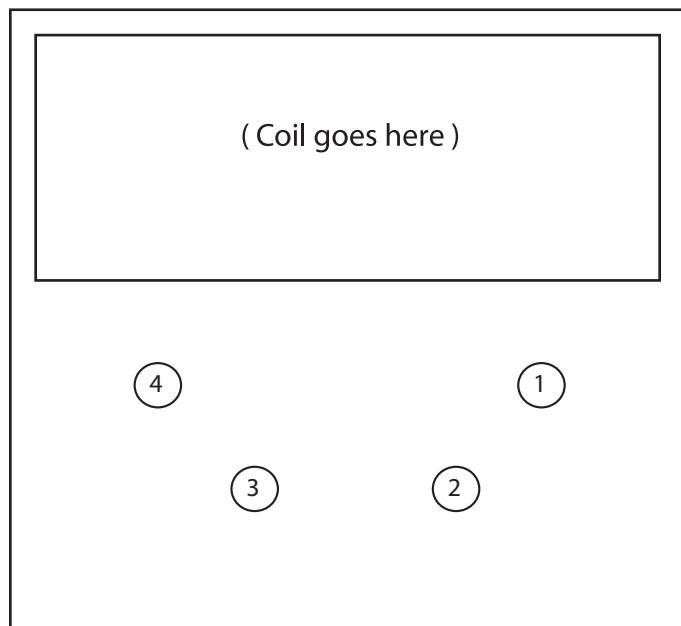
#### 4. Ground Wire:

Solder a mini alligator clip to one end of a two-foot piece of hookup wire (I used a different colour, but it doesn't matter), and strip 3/4 inch of insulation off the other end.

#### 5. Hookup Wires:

Cut two pieces of hookup wire, approximately three inches in length

## Template



each, and strip 3/4 inch of insulation off both ends.

Once I had all the pre-assemblies done, I put each set together in a plastic baggie, to keep it simple for distribution.

### Craft Time!

Prior to the meeting for this craft, we had just finished showing off a short-wave radio and talking about how signals are transmitted through the air. I also brought in my prototype model (see photograph right) and explained that this was a real, working radio that needed no batteries that they could build! We also talked about how these were the first types of radios, before the invention of transistors, walkmans, and CDs. (A couple of the adults waxed nostalgic about the old tube radios their parents had...)

To run this craft, make sure you have plenty of patient parent helpers, then proceed as follows:

Show off the prototype, and explain that you are going to do this in two parts – the hardest part will come first, and a much easier part second.

Distribute the baggies of goodies, pine boards, and toilet rolls. Tell the Cubs not to dump out the contents of the bags, as some of the parts are quite small.

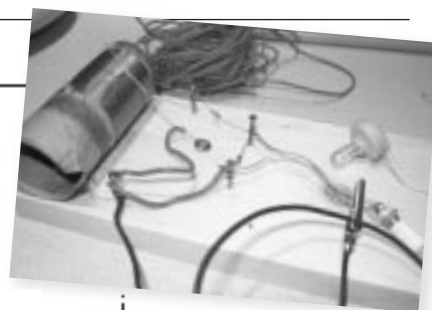
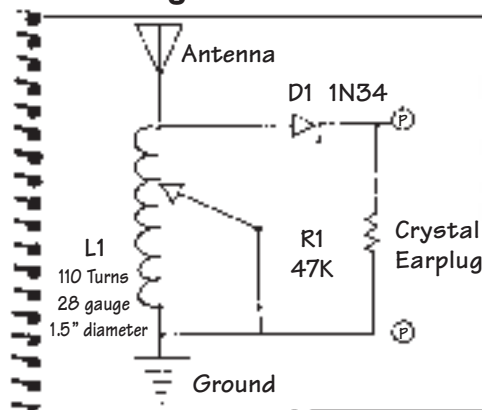
Get them to pull out the four nails from their baggies and hammer them in at the four circles shown on the wood. Make sure to tell them not to nail them all the way in – just enough to make them stick. They will be attaching wires to the nails later.

Cut a small diagonal slit in one end of the toilet roll. This is where the magnet wire will start.

Measure out the length of wire for them to wind around the roll for their coil (I was fortunate that I calculated the 110 turns would need about 660 inches of wire, and my finger-tip to finger-tip measurement was just about 64 inches, so I just pulled off 10 arm-lengths of wire for each Cub). Make sure not to kink the wire, and move each Cub (and parent) off to a separate part of the hall, so their wires won't tangle. Leave about six inches outside of the roll, insert one end of the wire into the slot, and hold it there with a little dab of glue from the glue gun. Then, show them how to wind two or three turns around the roll, sliding them together to make it neat.

Winding the coil usually takes about 10 to 15 minutes, with parent help. Be sure to leave about six inches free at the end, and use the glue gun

### Circuit Diagram



Slider  
(top view)

Straight End  
(side view)

to seal down the last few turns. Then, glue the coil onto the board, using the glue gun, in the position shown.

### Electronics Time

Here's the circuit diagram for the radio. (Again, thanks to <http://journeytoforever.org>)

Now, the fun stuff!

1. Wrap the stripped end of the antenna wire around the nail numbered 1.
2. Wrap the ends of the diode around nails 1 and 2. Note that there will be a 'band' around one end – that end should point toward nail 2.
3. The resistor should be attached between nails 2 and 3. It doesn't matter which way.
4. The wires from the earphone jack should also be attached to nails 2 and 3 – one to each nail, and again, it doesn't matter which way.
5. Attach one of the hookup wires between nails 3 and 4.
6. Attach the stripped end of the ground wire to nail 4.
7. Now, solder all the connections to the nails. (We had the Cubs come over to the 'soldering station,' run by a couple of the parents who knew how to solder).
8. To make the slider, straighten out the paper clip, then have one of the leaders use the needle-nose pliers to bend one end into a loop – just big enough for the screw to go through.
9. Bend up the straight end, so there's a bit of an angle, and so the slider doesn't crush the coil.
10. Put the washer on the screw, put the screw through the loop at the end of the slider, and screw it into the board (somewhere in the middle of the nails, so that the slider makes contact with the coil).

Screw this down relatively tightly, so the slider stays put, but can still be easily moved.

11. Solder one end of the remaining small hookup pieces to the slider, and the other to nail 3 or 4, whichever you prefer.
12. Remove about 3/4 inch of the enamel insulation from the free ends of the coil wires, using the sandpaper provided. It doesn't take much pressure. Just wrap the sandpaper around the wire and pull a couple of times. You should see the bright copper wire showing through.
13. Solder the wire coming from the coil end closest to nail 4 to that nail. Similarly, solder the wire coming from the coil end closest to nail 1 to that nail.
14. Using the sandpaper, gently remove the enamel coating from the coil where the slider will touch it. Sand in the direction of the coil (top to bottom), not across the wire (left to right). Again, a light touch is all that is needed.
15. Plug the earphone into the earphone jack. You're done!!!

To get really audible signals, you need a good ground to attach to. This can be difficult in modern homes, where plumbing is usually plastic, instead of metal. Basically, what you're looking for is a large piece of metal to connect to. I found success by clipping onto the metal part of the plumbing under my bathroom sink, or to the furnace ducting (I pulled up one of the floor vents, and clipped onto the metal ductwork).

Tuning is somewhat hit or miss, but can be a lot of fun. Have a great time with this audible project. Over and out! X

– Don Tolson can be found over the airways with the 5<sup>th</sup> Douglas Cubs in Victoria, British Columbia.