Cassette Box Special

Replace that Guy Lombardo tape with a 5-watt 80m transceiver!

by Michael Jay Geier KB1UM

The search for suitable cabinets for my electronic projects has led me to everything from Radio Shack project boxes to dessert containers to pillboxes! My perennial favorite, though, is the cassette box. These cheap little gems are great for lots of things, including meters, battery holders, switchboxes, and even entire perfboarded circuits. And after I've used my $1.50 housing, I still have a cassette! What a bargain.

So, naturally, it seemed like a good idea to try to build an entire transceiver inside one. As it turned out, it wasn't even an especially tight squeeze.

I wanted the rig to be stable and sensitive, to have some active filtering on the receiver, and to generate sidetone in transmit. Also, it should include a key, and put out enough power to make real contacts. And, as always with my projects, coil winding should be kept to a minimum (I hate winding coils).

The result is the Cassette Box Special. It's a 5-watt, 80-meter crystal-controlled rig with a direct conversion receiver. It has only one very simple coil to wind, and only one set-and-forget adjustment! It uses 12 volts, and pumps audio to a pair of "Walkperson" headphones.

Circuit Description

Q1 is the crystal oscillator for both receive and transmit. It's a MOSFET. Radio Shack used to carry it, but has discontinued it. Check your local store—there are still plenty of them on the shelves. In fact, that's where I got mine. If you can't find one locally, you can order it from the parts supply sources shown at the end of the article.

In transmit the oscillator's output, shifted down approximately 700 Hz by C4, feeds Q2 (the driver), and Q3 (the final), which is also a MOSFET (and is still in the Radio Shack catalog). The driver and final are keyed together, while the oscillator runs full time. Q3's output is filtered by L4 and its associated capacitors, and fed via the TX/RX switch to the antenna. C15 generates the sidetone by forcing the audio amps into oscillation. R14, at the audio output, cuts the sidetone level down to keep it from knocking your head off.

In receive, the oscillator feeds gate 2 of Q4, the mixer. Gate 1 is fed with the incoming signal, tuned by L1 and C12. Careful attention to the design of the input coupling (by L2 and C11) results in minimal detection of unwanted AM signals. The mixer's output is fed to the high gain audio stages, Q5–Q7. Capacitors in the gate and drain leads of Q5 form a low-pass filter, removing some of the high frequencies which may be present in the received signal. C20, in conjunction with audio output transformer T1, provides a strong peak in the audio passband around 700–800 Hz and, with Q6, forms a fairly steep active filter. The transformer feeds the "Walkperson" headphones, driving them with plenty of volume.

Finding the Parts

The TX/RX switch has to perform six functions, so a single 6PDT switch is your best bet. You can buy one, or you may be able to scrounge one up for almost nothing. Kiddie walkie-talkies and cassette tape recorders have this type of switch—you may have a few lying around. I got my switch at a hamfest. Of course, you can also gang several switches together, or even use a relay, though it had better be a small one if you want to get this thing into a cassette box.

The crystal can be a surplus unit or one ordered from a crystal house. Try to get a high-activity crystal. Most rocks work well, but some can be sluggish, reacting badly to

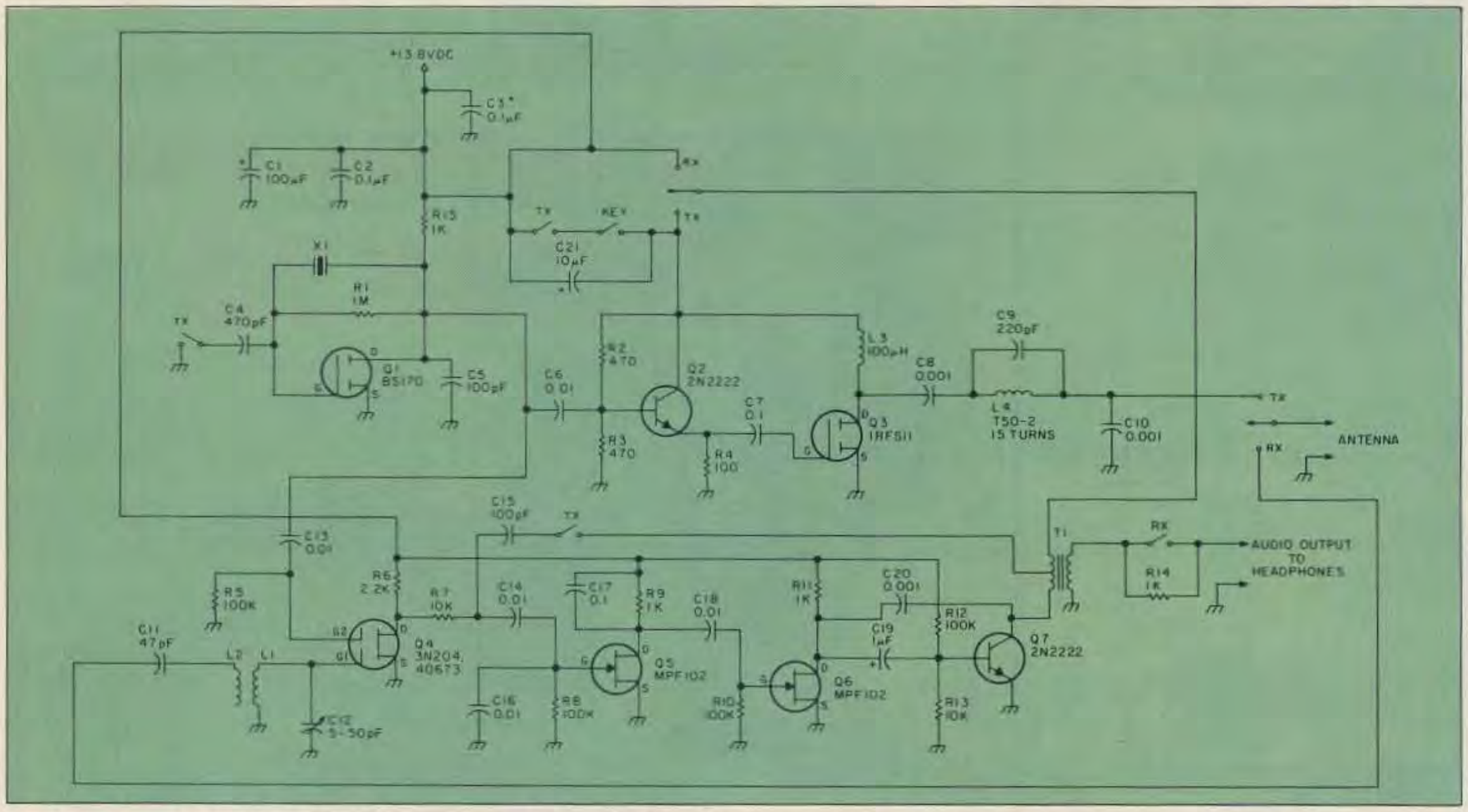
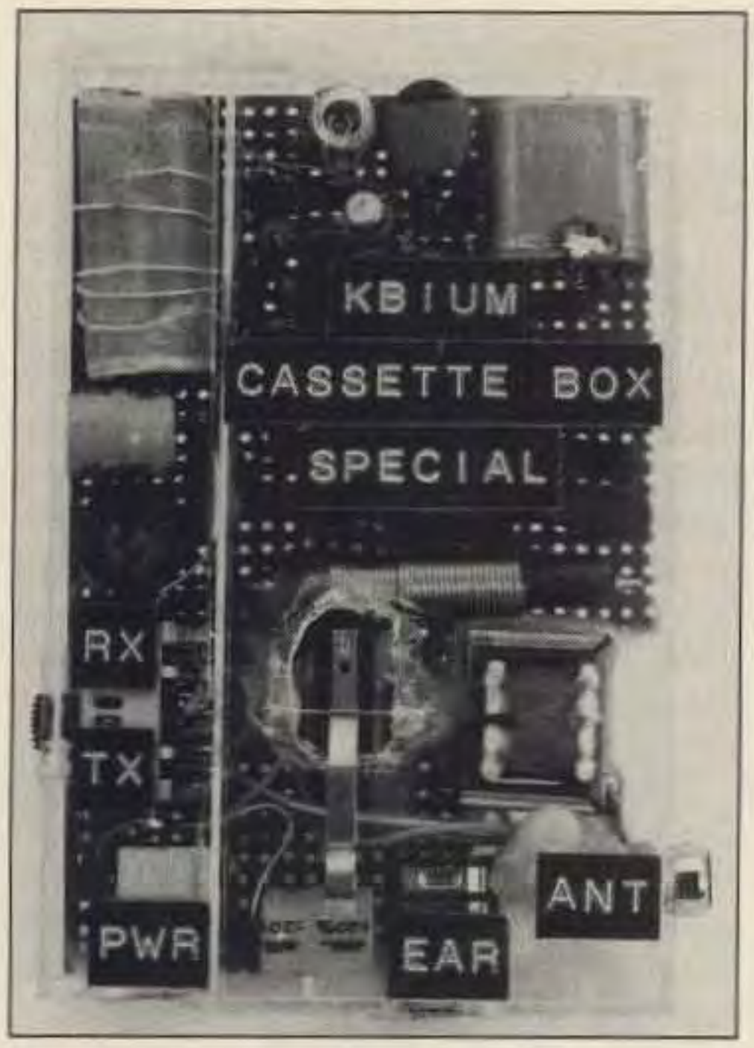
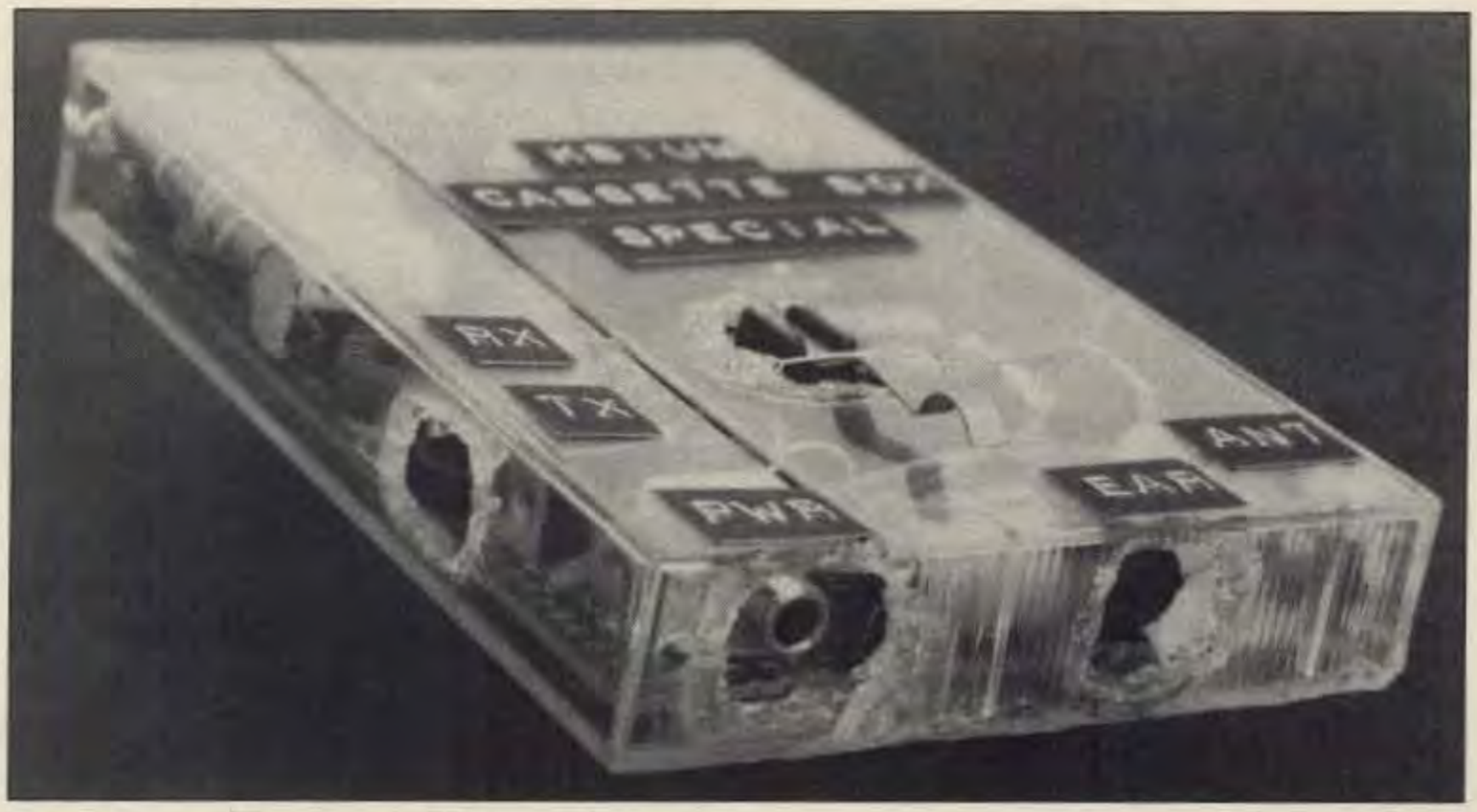


*Figure 1. Schematic for the KB1UM "Cassette Box Special." The switch contacts are marked as when their functions are closed. That is, a switch marked TX should be closed in transmit and open in receive. *C3 mounted right at B + input.*





The "Cassette Box Special" 80m CW transceiver.

the change in load presented to the oscillator when you key the rig. In particular, avoid 3.579545 MHz colorburst crystals, as many don't work too well. Besides, using that frequency is just asking for TVI problems, both to and from your neighbors. You'd be amazed at how loud their TVs' color oscillators can sound in your receiver. Good frequencies to try are 3.560 MHz and 3.710 MHz, the recognized QRP frequencies.

The type of crystal you use may affect the amount of transmit offset provided by C4. For more offset, increase the value of C4; for less, decrease it. You can get multiple frequency operation by using more than one crystal and a selector switch, if you can fit it all in the box. If the frequencies are as widely spaced as those two, though, you may have to retune C12 when you switch frequencies.

L1 is an antenna coil from an AM transistor radio. At worst, you can buy a radio and remove the coil. I used one from a Radio Shack Flavoradio, and it worked fine. Just about any AM coil should do. If it has a tap or other windings, leave them unconnected and use the longest winding. Simply remove the coil from its ferrite core and then wind 5 turns of wire-wrap or similar wire around it, spread out over its length, to make L2.

Winding

There's only one coil to make. Get a T50-2 toroid and wind 15 turns of #26 enameled wire, spreading it two-thirds around the toroid. Coat it with nail polish to hold the windings in place, and you're done.

Construction Details

The key word here is "flat." First, prepare the cassette box. I used a clear one, and I suggest you do the same. They're popular and easy to find, and the result is pretty and interesting. Separate the two halves, and then clip off the spindles with a pair of dikes. Be careful not to crack the box, as the plastic is very brittle. Now, run your soldering iron over the spindle stumps to flatten them out.

A few words about working with this kind of plastic: The only way I've ever found to do it is with heat. Attempts at drilling resulted in a cracked or broken box. The stuff melts easily and can be shaped or formed any way you like. Try not to breathe the smoke, though, as it can't be very good for you. Also, always wipe and tin your iron tip after it touches the plastic, or the tip may become too contaminated to melt solder. If possible, use a separate, cheap iron to do your plastic melting..

You will have to make some holes in the box, but save that until after you've built the board, because the holes' locations will depend on your placement of the switches and jacks.

Parts List

Q1	BS170	Digi-Key BS170
Q2,Q7	2N2222	RS 276-2009
Q3	IRF511	RS 276-2072
Q4	3N204 or 40673	Jameco 40673
Q5,Q6	MPF102	RS 276-2062
X1	CRYSTAL	
L1	AM antenna coil from radio	
L2	5 turns spaced over length of L1	
L3	100 µH choke	RS 273-102
L4	15 turns #26 enameled wire on T50-2 toroid	Radiokit T50-2
T1	1KΩ CT to 8Ω audio output transformer	RS 273-1380
C1	100 µF, 25V or more	
C2,C3,C7,C17	0.1 µF	RS 272-109 (5 per pack)
C4	470 pF	
C5,C15	100 pF	
C6,C13,C14, C16,C18	0.01 µF	
C8,C10,C20	0.001 µF	
C9	220 pF	
C11	47 pF	
C12	5–50 pF trimmer	RS 272-1340
C19	1 µF, 25V or more	
C21	10 µF, 25V or more	
R1	1 megΩ	
R2,R3	470Ω	
R4	100Ω	
R5	100KΩ	
R6	2.2KΩ	
R7,R13	10KΩ	
R8,R10,R12	100KΩ	
R9,R11,R14,R15	1KΩ	
RX/TX SWITCH 6PDT		
Heatsink	TO220	RS 276-1363

Sources:	Digi-Key Corp. 701 Brooks Ave. South P.O. Box 677 Thief River Falls MN 56701-0677 (800) 344–4539	Radiokit PO Box 973 Pelham NH 03076 (603) 635–2235

Cut a piece of perfboard to fit the cassette box. If you use the Radio Shack audio output transformer, as I did, you will have to cut away enough of the board to allow the transformer to fit in the box, because it is too thick for mounting on the board. In fact, the transformer doesn't quite make it as it is, and the plastic flanges where the wires exit will have to be melted a little to make it slightly thinner. If you can get a smaller transformer, do so, although you may have to experiment with the value of C20 to make it resonate around 700 Hz. The exact frequency isn't critical; you just want it to peak somewhere near the CW pitch you like to hear.

The final transistor must be heat-sinked. Don't forget to use silicone heatsink grease for efficient heat transfer. Bend the fins of the heat sink flat so it will fit into the box.

Assemble the circuit, placing the TX/RX switch and power, earphone, and antenna jacks at the edges of the board. Although layout isn't critical, try to keep the audio output transformer away from the antenna coil (L1/L2), or feedback can occur. Be especially careful to wire the TX/RX switch correctly. I have marked the switch contacts as to their function when closed. That is, a switch marked TX should be closed in transmit and open in receive. The two double-throw contact sets are marked in obvious fashion.

If you can't find a 100 µF capacitor (C1) that's thin enough, use two 47 µF caps in parallel. The exact value isn't critical. Also, place C3 (0.1 µF) right at the DC power input jack for maximum protection from RF feedback and instability.

I used an eighth-inch earphone jack for DC power, a stereo jack for the headphone output, and a phono jack for the antenna. Wire the headphone jack using only the tip and midpoint, leaving the ground (ring) unconnected. That way, the left and right phones work in series, which seems to provide the best sensitivity. Also, I used a microswitch with a lever arm for the key, mounting it on the board so that it stuck out through a hole in the top of the box. If you elect to use a separate key, keep the wires under one foot in length. Do not use an electronic keyer, as all the current for the transmitter passes through the key!

After assembly, check for any wiring or polarity errors. Be especially careful to match the polarity of the DC power jack to that of your power source! Next, place the TX/RX switch in receive and then connect power, antenna, and headphones. Adjust C12 for maximum signal or band static. It should sit at about ¼ total rotation. The peak is very sharp, and it may take a few tries before you get it just right. I made a hole in my box so that I could touch it up if necessary.

Slide the board into the large part of the cassette box and mark the spots for the holes for the switch, key, and jacks. When you're done making them, assemble the box and melt the edges together. That's it!

Operating Tips

The radio is designed to operate from 12 volts, and will work OK from about 10–14. At 12 volts, it produces approximately 5 watts in transmit. Use D batteries or a gell-cell, as the transmitting current drain is substantial enough to wipe AA cells out in short order.

Like most direct conversion rigs, the receiver is fairly microphonic. That is, if you tap on it, you'll hear it in the headphones. It should not oscillate or show any other kind of instability. If it does, try reversing the output leads from T1 (the side going to R14). Also, the rig is best operated on battery power, to avoid hum problems. In some locations you may get some hum induced from the table on which the rig sits because there is no shielding in the box. Try placing the radio on the battery pack.

There is, of course, no sideband filter, so you'll hear signals on either side of zero beat. If you hear a strong signal but get no response to your call, the other station may be listening on the wrong sideband to hear you! Oh well, such is life in the direct conversion world.

Finally, avoid long keydown periods. Although the rig is stable into all but the worst SWR, the heat sink is small and gets pretty hot. You'll notice the box getting warm, but it shouldn't be a problem with normal use.

Enjoy your "Cassette Box Special." You'll have fun with it on the air, and it's guaranteed to turn a few heads when you show it around! 73

Michael Geier KB1UM is 73's troubleshooting "Ask Kaboom" columnist. You can reach him at PO Box 64766, S. Burlington VT 05406.