The "Ugly Weekender" II: Adding a Junk-Box Receiver

To many low-power enthusiasts, operating a 100% home-brewed station maximizes the joy of QRP. Here's a simple way to expand a popular QRP transmitter design into a complete direct-conversion transceiver.

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The original Ugly Weekender article[1] described a simple 40-meter QRP CW transmitter. It offered electronic TR switching and chirp-free operation, and its output power of 1.5 watts has proven to be quite adequate for the casual backpacking trip, Field Day, or study break. The original article didn't cover an obvious requirement, however: a companion receiver.

Making one alteration to the VFO circuit and adding the receiver described in this article turns the Ugly Weekender into a fully functional transceiver. The Ugly Weekender receiver is built with many common parts, most of which are probably already in your junk box. Constructing the receiver shouldn't take more than an evening or two.

The Receiver Circuit

A copy of the Ugly Weekender article (see Note 1) is essential in constructing the receiver. In its original form, the Ugly Weekender consists of a four-stage, 7-MHz CW transmitter designed for ease of duplication. The receiver circuit (Fig 1) connects to the existing Ugly Weekender VFO and keying circuits. The added circuitry consists of a product detector, audio amplifier, muting circuit, sidetone generator and a crystal calibrator that can help you keep your Ugly Weekender on frequency.

[1]Notes appear on page 30.

The Ugly Weekender receiver is a classic direct-conversion design. The transmitter's 7-MHz VFO (applied via **Local Oscillator Input**) is used to "beat" incoming signals (at **RX RF Input**) to audio in the product detector consisting of diodes D8-D11 and transformers T4 and T5.[2] The transmitter VFO circuit includes a jack (J4, **AUX OUT**) that provides VFO energy for this purpose. Antenna RF for the Ugly Weekender receiver is available at the transmitter's jack J4, **TO RECEIVER**, associated with the transmitter output network.

The product detector output is increased to high-impedance-headphone level by a four-transistor amplifier chain (Q8-Q10 and Q12). Careful attention was given to suppressing power-supply hum. The active decoupling circuit (Q11 and associated components) helps eliminate this problem. More details are provided in "An Optimized QRP Transceiver" by Roy Lewallen, W7EL.[3] All transistors in the receiver circuit are 2N3904s, or equivalent.

The original Ugly Weekender receiver was designed to drive only a high-impedance load. I recently added an LM386 IC audio power amplifier to drive a favorite pair of portable hi-fi headphones. Fig 2 shows the additional gain stage.

The Ugly Weekender transmitter's **B** terminal provides +12 V during key-down periods. This signal is applied to Q15 in the receiver. Q15, an emitter follower, switches power-supply current to the sidetone oscillator (Q16-Q17) and the mute switch (Q13). The sidetone oscillator is a multivibrator. Q13 shuts the receiver audio off by pulling the base of Q12 to ground.

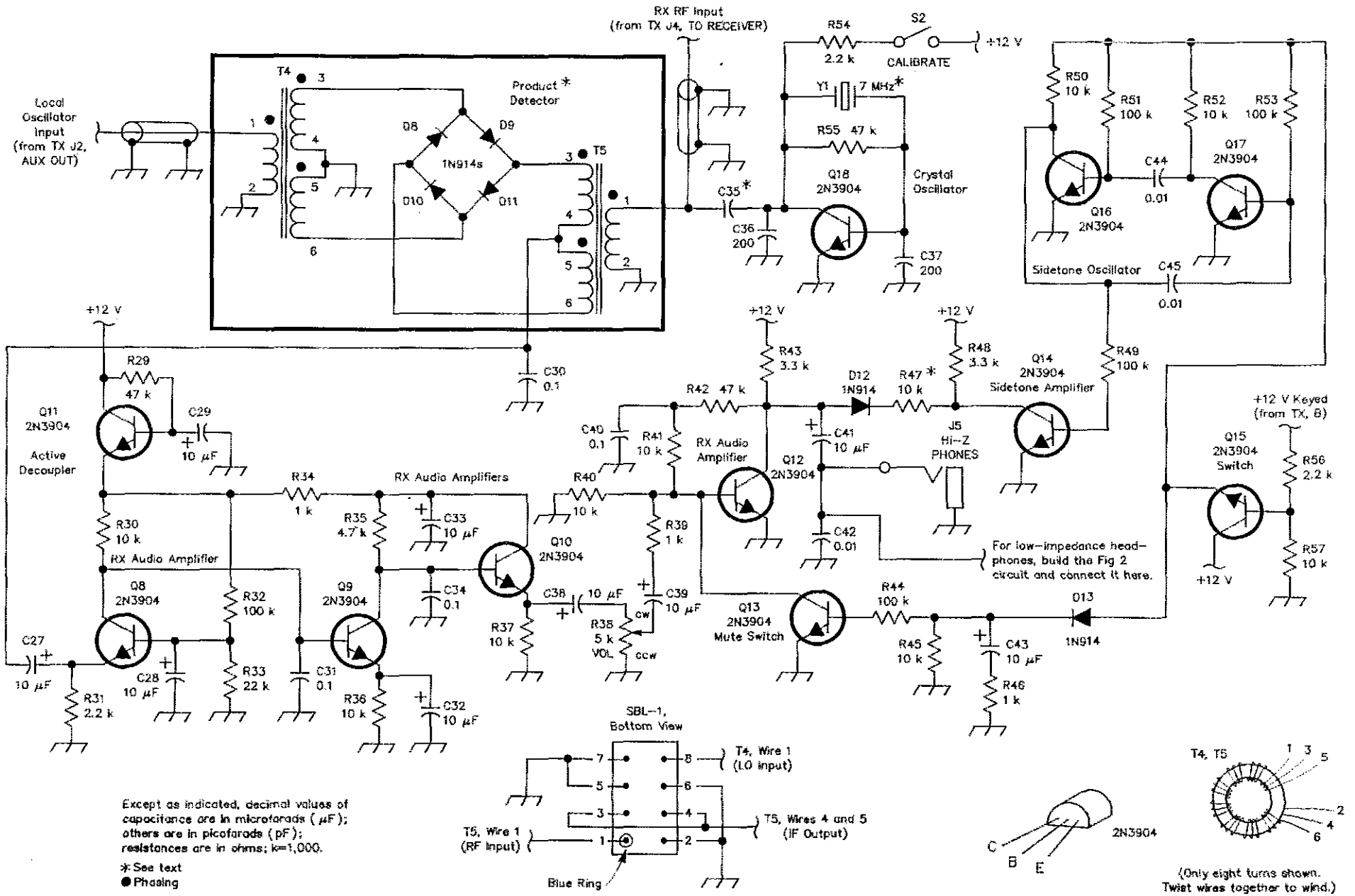
Semi-break-in delay is accomplished by R45, R46, and C43, near the base of Q13. R45 provides a discharge path for C43 after key-down is complete. Although the JFET switching scheme described by W7EL for the Optimized Transceiver would provide cleaner, click-free muting, the Q13 circuitry is adequate.

The sidetone is injected into the Ugly Weekender's audio output by a separate amplifier, Q14. Sidetone volume is fixed; increasing the value of R47 lowers the volume of the sidetone.

Crystal Calibrator

The final Ugly Weekender Transceiver design includes a crystal oscillator (Q18). Over time, I discovered that the coarse and fine VFO tuning knobs can easily get bumped out of adjustment when transporting the unit. Use of a band- or subband-edge crystal is suggested. S2, **CALIBRATE**, turns the oscillator on and off.

The calibrator signal is capacitively coupled into the receiver RF chain by running a wire across to the mixer circuitry. The mixer end of this wire is left unconnected. (Fig 1 shows the capacitance obtained by this arrangement as C35.) If the signal from the crystal calibrator is too strong for your ears, move the wire a little farther from the mixer to lower the



Except as indicated, decimal values of capacitance are in microfarads (µF); others are in picofarads (pF); resistances are in ohms; k=1,000.

*See text

● Phasing

Fig 1—The Ugly Weekender receiver uses easy-to-get parts and goes together in an evening or two. The receiver's unpolarized capacitors are disc ceramics; its polarized capacitors are aluminum or tantalum electrolytics rated at 16 to 35 V dc. Its resistors are 5- or 10%-tolerance, ¼-watt, carbon-film or -composition units. The inset shows how to wire a Mini Circuits SBL-1 mixer in place of T4, T5 and D8-D11 (see Note 2); the SBL-1 replaces the boxed components in the main drawing. Component designators not listed below are for the purpose of PC-board part placement (see the "Ugly Weekender PC Boards?" sidebar). This circuit is designed to drive high-impedance headphones; Fig 2 shows an add-on amplifier capable of driving low-impedance phones or a speaker.

D8-D13—Silicon switching diode, 1N914, 1N4148, 1N4152 or equivalent (D8-D11: see Note 3).
R38—5 kΩ, audio-taper control.
Q11-18—2N3904 or equivalent.
T4, T5—10 trifilar turns #28 enameled wire on a toroidal ferrite core, FT-37-43 (0.37-inch OD, Mix 43 ferrite) or equivalent. See Note 2.

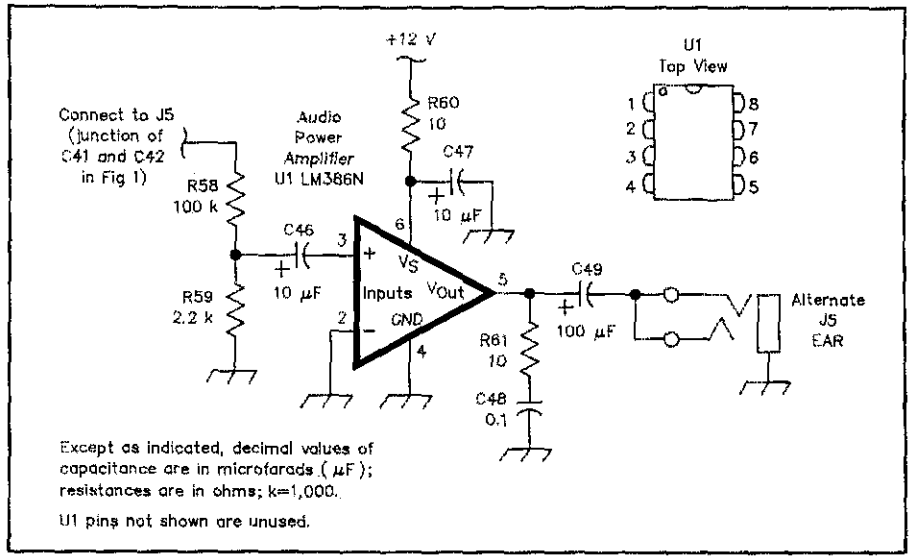


Fig 2—Adding this amplifier allows the Ugly Weekender II to drive low-impedance audio loads. The component information in the Fig 1 caption also applies to this circuit. U1 is an LM386 audio power amplifier IC.

coupling effect. One advantage of the ugly construction technique is that this value may be adjusted at any time, even in harsher portable environments. If the carrier needs to be louder, just open the rig and move the wire. If necessary, the end of the wire may be wrapped around the center conductor of the **RX RF Input** coax to provide sufficient coupling.

Modifying the Existing Transmitter

The Ugly Weekender VFO must be altered slightly in order for the VFO to be shared by the receiver. As originally designed, the VFO shifts approximately 25 kHz higher than its operating value during receiving periods. Altering the VFO to shift only a few hundred hertz is accomplished by shunting D2 (in the original Ugly Weekender VFO/buffer schematic) with a capacitor. I used a 200-pF, silver-mica unit, which yields a shift of about 600 Hz. (More capacitance equates to less shift.) This shift becomes the correct pitch at which to tune in received signals for transmitter zero beat.[4]

Construction Hints

The original mechanical layout of the transmitter was not changed. The BNC connector at J4 was replaced with a less-expensive phono type, and appropriate connectors were added to the VFO/buffer circuitry to provide the necessary signals to the receiver. All signal lines required by the receiver were routed behind the chassis.

As the title photo shows, I bolted an additional LMB SL-139 chassis box onto the lid of the original amplifier module. A scrap piece of copper-clad PC-board material was bolted onto the base of the box. Starting with the mixer, I wired the circuit from left to right, just as shown in the schematic. Fig 3 details the receiver interior.

When building any circuit on copper-clad board, you may tend to get a little carried away before realizing where the circuit is going. I've found that approaching every circuit transistor by transistor works well. Give a little thought to your layout, and where the next stage will be constructed. This will keep you from working your way into a corner. It may work out better to solder some components together before setting them onto the copper ground plane.

All components are soldered to each other in point-to-point fashion. Any component with a grounded lead can be soldered directly to the copper ground plane. *Important:* The ground plane must be provided with a *real* supply ground line. Don't rely on the chassis and board-to-chassis fasteners to provide this path.

High-value resistors can act as standoffs when additional mechanical support is required. At 12 V, any resistor value above 220 kΩ acts more like an insulator than a resistor. Additional standoffs can be added anywhere within the receiver chain, although few are required for this circuit. I managed to build the entire receiver stage without a single additional standoff. Although the completed receiver won't win any neatness awards, its structural integrity has yet to fail!

Operating the Ugly Weekender II

After completing the receiver, it's time to get on the air. Before transmitting, be sure you know where the VFO is tuned. Turn on the crystal oscillator and tune the coarse adjustment (C1) until the crystal's frequency is reached. It may be convenient to calibrate the main tuning knob (C2, **VFO TUNE**) before portable operation is attempted. The title photo shows an example of this. I set **VFO TUNE** to the double dots. Then I tune with C1 to zero-beat the transceiver's calibration oscillator (about 7024 kHz with the crystal I used).

Check the VFO shift modification by turning on the **SPOT** switch and zero-beating any incoming signal (the calibrator, for instance). Turning off the **SPOT** switch should make the signal of interest audible at the transmit offset (600 to 800 Hz, depending on the value you shunted across D2 in your Ugly Weekender).

For *Real* QRP Fun, Go Portable!

Constructing the Ugly Weekender transmitter is a quick way to get on the air from your home. With not much more than a handful of components and a slab of copper-clad circuit board, you're on the air. Adding this receiver circuit will allow you to take the Ugly Weekender into the sticks on your next outdoor adventure!

Many operators find QRP operating frustrating. One way to overcome this feeling is to add one more dimension to operating QRP: Go portable! I've found that the real fun comes when your QTH is somewhere far away from your home station, where that 100-W HF rig may be begging for some attention. Many portable locations work very well: the beach, the mountains, a snow cave, a boat, etc. These locations not only enhance the joy of QRP operating, but they can also increase your effective signal strength. In a boat, especially on salt water, you have a very good ground plane that helps your signal carry. If you're on a mountaintop, your increased height above average terrain can (under certain conditions) increase your effective radiated power. Sometimes, the view from a portable QTH is so overwhelming that you forget to get on the air!—*KA7EXM*

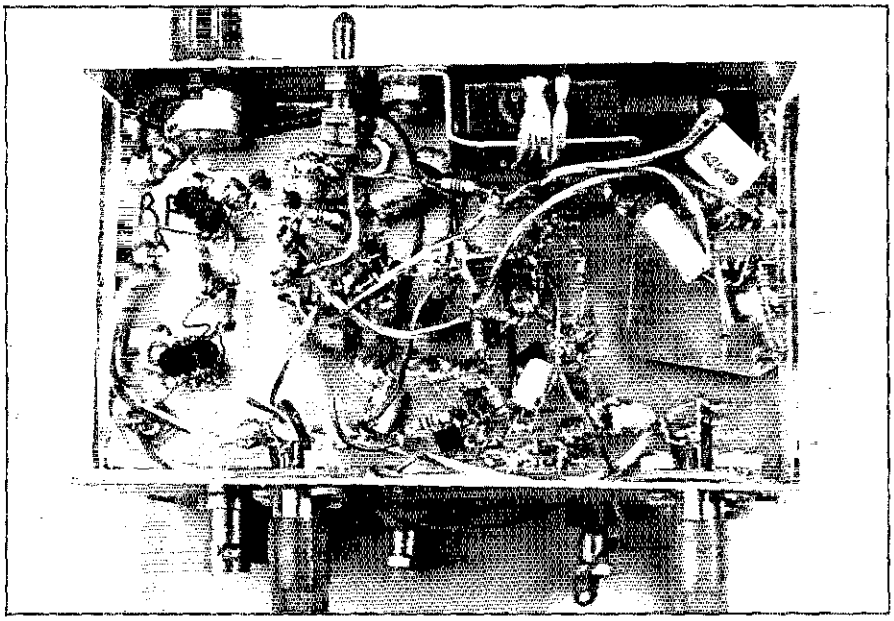


Fig 3—Interior view of the receiver, with the front panel at the top. Product-detector transformers T4 and T5 appear at the left, just below the audio VOLume control, R38. A rubber band holds Y1, the marker crystal, snug against its retaining bracket. A small daughterboard, right, carries the LM386 amplifier circuitry. The U1 stage could have been built on the main board, but keeping the LM386 amplifier's ground foil separate from that of the rest of the receiver helps avoid audio feedback problems. A single wire connects the LM386 board foil to chassis at the EAR jack (alternate J5, Fig 2). *(photos by Kirk Kleinschmidt, NTØZ)*

Unlike the single-signal superheterodynes commonly used by hams, this simple direct-conversion receiver causes every signal to be heard "twice" as you tune through it. Only one (the lower-frequency) of the two **VFO TUNE** settings that receive a given signal at the transmit-offset pitch correctly tunes the Ugly Weekender's transmitter to incoming signals. The **SPOT** switch allows you to tune correctly every time by defeating the transmit offset. Just turn on **SPOT**, tune the desired signal to zero beat (as close to 0 Hz as your ears can detect), and turn off **SPOT**. You might even consider bandscanning with **SPOT** already turned on. Then, when you hear a station you want to contact, tune it to zero beat, turn off **SPOT**, and you're ready to call.

Contest operation calls for a faster spotting procedure. The title photo shows part of the solution: an arrow (just above the **VFO TUNE** knob). To spot with the tuning arrow, keep the **SPOT** switch turned off. Starting at a frequency above the desired signal's, turn **VFO TUNE** *in the direction the arrow points*—that is, to decrease frequency—until the station you want to work comes in at the transceiver's CW-offset pitch. If you tune for this pitch from the low side of zero beat while moving *against* the arrow, your transmitted signal will be off by twice the frequency of the VFO shift—between 1 and 2 kHz! Without the arrow, you may find yourself yelling "Superhet!" to other members of your Field Day team.

Operating the Ugly Weekender transceiver has been very enjoyable. The excitement in operating this radio has been the greatest when operating in a portable environment, where the typical appliance couldn't be carried, or powered. From the Oregon Cascades, the radio's 1.5 watts has proven to be more than enough power to contact stations up and down the entire West Coast.

Summary

The original Ugly Weekender transmitter can be converted into a transceiver with not much more than a handful of components from your junk box. I encourage you to add this receiver to your Ugly Weekender and operate it portable sometime soon!

Acknowledgments

Thanks to Roy Lewallen, W7EL, for his teaching and encouragement. I have had the honor to operate his Optimized QRP Transceiver, the radio on which this design is based. Thanks also to my father, Wes Hayward, W7ZOI, for providing the design and the encouragement to write this article.

Notes

[1]R. Hayward and W. Hayward, "The 'Ugly Weekender,'" *QST*, Aug 1981, pp 18-21. The Ugly Weekender also appears on pages 30-33 to 30-36 of the 1992 *ARRL Handbook*.

[2]A Mini-Circuits SBL-1 may be used in place of this hand-assembled mixer. There is little performance difference between the two. The diode ring mixer is still the best product detector for low intermodulation distortion and immunity to amplitude-modulated broadcast signals.

[3]R. Lewallen, "An Optimized QRP Transceiver," *QST*, Aug 1980, pp 14-19; also see Feedback, *QST*, Nov 1980, p 53. The Optimized QRP Transceiver also appears on pages 30-37 to 30-40 of the 1992 *ARRL Handbook*, and in the second printing of *QRP Classics* (available from the ARRL Bookshelf as #3169). The Ugly Weekender is heavily based on Roy's design.

[4]The mechanics of CW offset are described in G. Collins and D. Newkirk, "Transceiver Features That Help You Beat Interference," *QST*, Mar 1991, pp 16-21.

Ugly Weekender PC Boards?

In order to simplify construction, no PC boards were used in the original Ugly Weekender. Instead, a point-to-point wiring technique now known as *ugly construction* was described.*

This construction technique utilized in the original transmitter has proven to be as reliable as PC-board construction. In the past 10 years, the radio has logged many miles in my backpack during various outdoor excursions and Field Day events. No failures have ever occurred. Because of this proven reliability and ease of construction, the Ugly Weekender receiver was also built with ugly-construction techniques.

If you are involved in a club, and wish to replicate this circuit in quantity, it may be better to build the receiver on a printed circuit card. Or you may simply prefer PC-board to ugly construction. PC boards are available for the Ugly Weekender receiver and VFO.† However, I encourage everyone to try ugly construction before simply purchasing an etched circuit board. Ugly construction costs less, works as well (and sometimes better!) and lets you get started in building *now*.—*KA7EXM*

*You can learn more about this technique, also called *ground-plane* construction, in B. Hale, "Build It Yourself from QST," *Part 2*, QST, May 1992, pp 35-39.—*Ed.*

†Etched, plated and drilled PC boards are available from FAR Circuits, 18N640 Field Ct, Dundee, IL 60118-9269. Prices: Ugly Weekender VFO/buffer, $4; Ugly Weekender receiver, $6; Ugly Weekender transmitter, $5; all three boards as a set, $11. Add $1.50 shipping and handling to each order. Check or money order only; credit cards are not accepted. Part-placement diagrams are included with each order.

PC-board templates and part overlays for the Ugly Weekender VFO/buffer and receiver boards are available free of charge from the ARRL Technical Department Secretary. With your request for the UGLY WEEKENDER PC BOARD TEMPLATE PACKAGE, send a #10 SASE.

Licensed since 1979, Roger Hayward holds an Advanced Class license and is active in VHF mountaintopping, HF operating and applying DSP techniques in ham radio. He obtained a Bachelor's of Science in Electrical and Computer Engineering from Oregon State University, Corvallis, Oregon, in 1987, and will receive his Master's degree in Electrical Engineering from OSU this month. His area of study involves digital signal processing and communications systems; his MS thesis involves improved simulation techniques for sampled-data systems. Roger is a development engineer for Mentor Graphics. QST