Number 16 on your Feedback card

CARR'S CORNER

Joseph J. Carr K4IPV
P.O. Box 1099
Falls Church VA 22041

A "Universal" VFO Project

Variable frequency oscillators (VFOs) can be used to control the operating frequency of receivers or transmitters, or as a signal generator for testing radio and electronic circuits, or for a large number of other applications. This month's column is dedicated to a small VFO project, built on a printed circuit board, that can be incorporated into any of several different projects that you might design.

The Circuit

Figure 1 shows the basic circuit for the VFO, except for the tuning circuits (which are shown in Figure 2). Transistor Q1 is a junction field-effect transistor (JFET) oscillator stage. The device to use at Q1 includes MPF-102, 2N4416 and the replacement devices from the popular lines of "service" parts (e.g. ECG and NTE). The NTE-452 and ECG-452 can replace the 2N4416, while the NTE-312 or ECG-312 can replace MPF-102 devices. The ECG and NTE devices can usually be bought through local electronic parts distributors who cater to the service and repair industry. Alternatively, NTE replacement semiconductors can be ordered from Ocean State Electronics [POB 1458, 6 Industrial Drive, Westerly RI 02891; 1-800-866-6626 (orders); 1-401-596-3080 (voice); 1-401-596-3590 (fax)].

The oscillator is followed by a two-stage buffer amplifier consisting of Q2 and Q3. The selections for Q2 are the same as for the oscillator. For Q3, use a 2N2222 or some similar NPN silicon device.

Two different oscillator configurations can be accommodated by this design (i.e. both Clapp and Colpitts oscillators can be built). Both oscillators are the same from point "A" in Figure 1 forward, and both depend on a capacitor voltage divider feedback network. The Clapp oscillator (Figure 2a) is series-tuned, while the Colpitts oscillator is parallel-tuned (Figure 2b).

The tuning circuits shown in Figure 2 consist of an inductor (L1) and several capacitors. One of the capacitors is the main tuning capacitor (Ctun), and another is a trimmer capacitor (Ct). Several fixed capacitors (Ca1-Ca3) can be used (optional) in order to craft an L-C tuned circuit with exactly the right capacitance and tuning range. It is not necessary to use any of these capacitors. You may also lump all of the fixed capacitance into a single capacitor, if desired.

The DC voltage supplied to the oscillator transistor (Q1) is voltage-regulated. The voltage regulator can be any 78Lxx series from 78L05 to 78L09. If the 78L05 is used, there may be some problems getting it to oscillate. I didn't experience any such problems in this particular case, but in other cases the lower voltages produced some problems. However, drift is typically lower when the lower voltages are used.

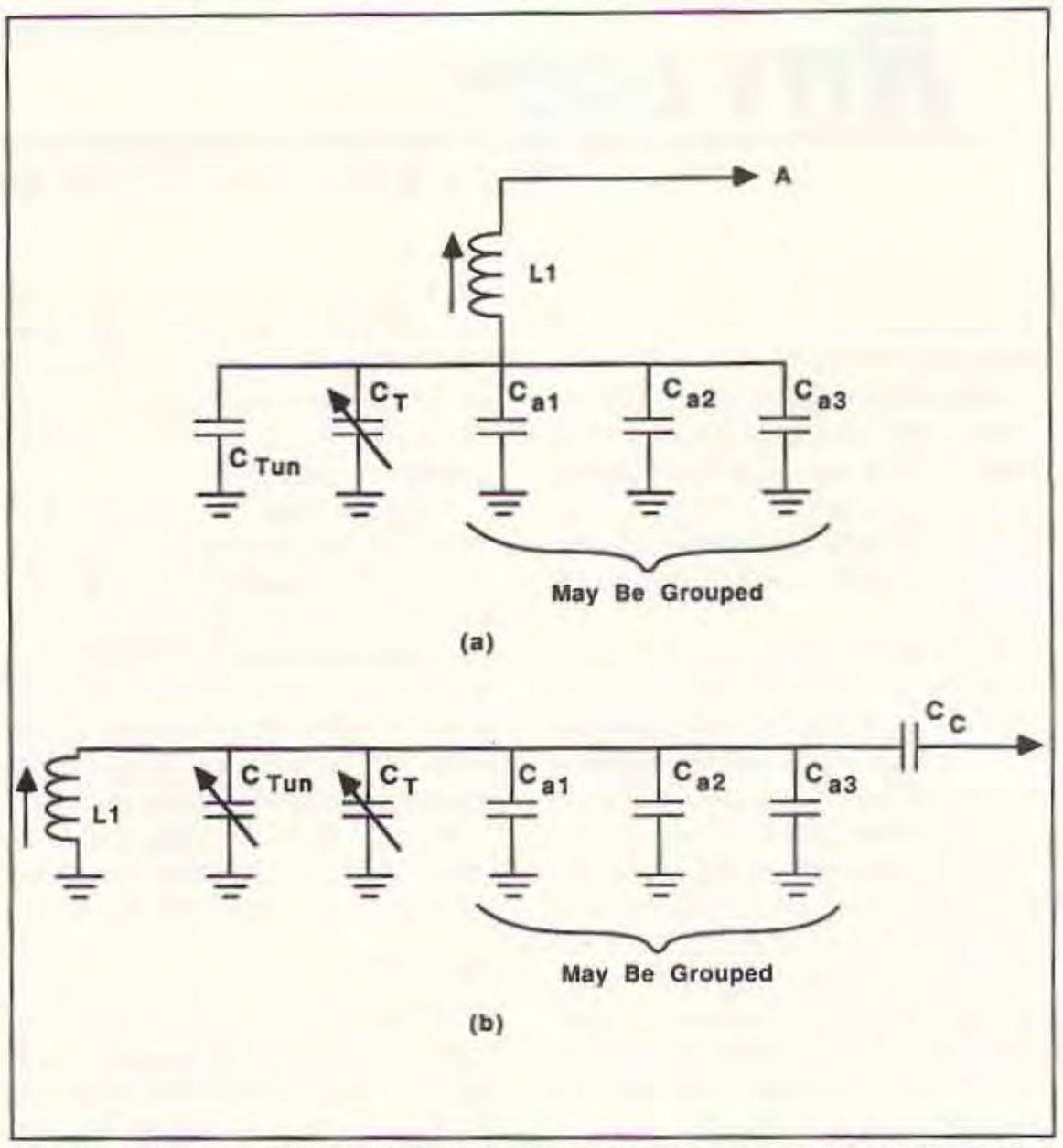

Figure 2. Tuning section of the VFO circuit: a) series-tuned Clapp; b) parallel-tuned Colpitts.

The values for the components can be developed from guidelines given by Doug DeMaw in *Solid-State Design for the Radio Amateur* (ARRL publication), p.34. As starting points (some experimentation may be needed) he recommends that L1 have a reactance of 140 ohms in the Colpitts case, and 260 ohms in the Clapp

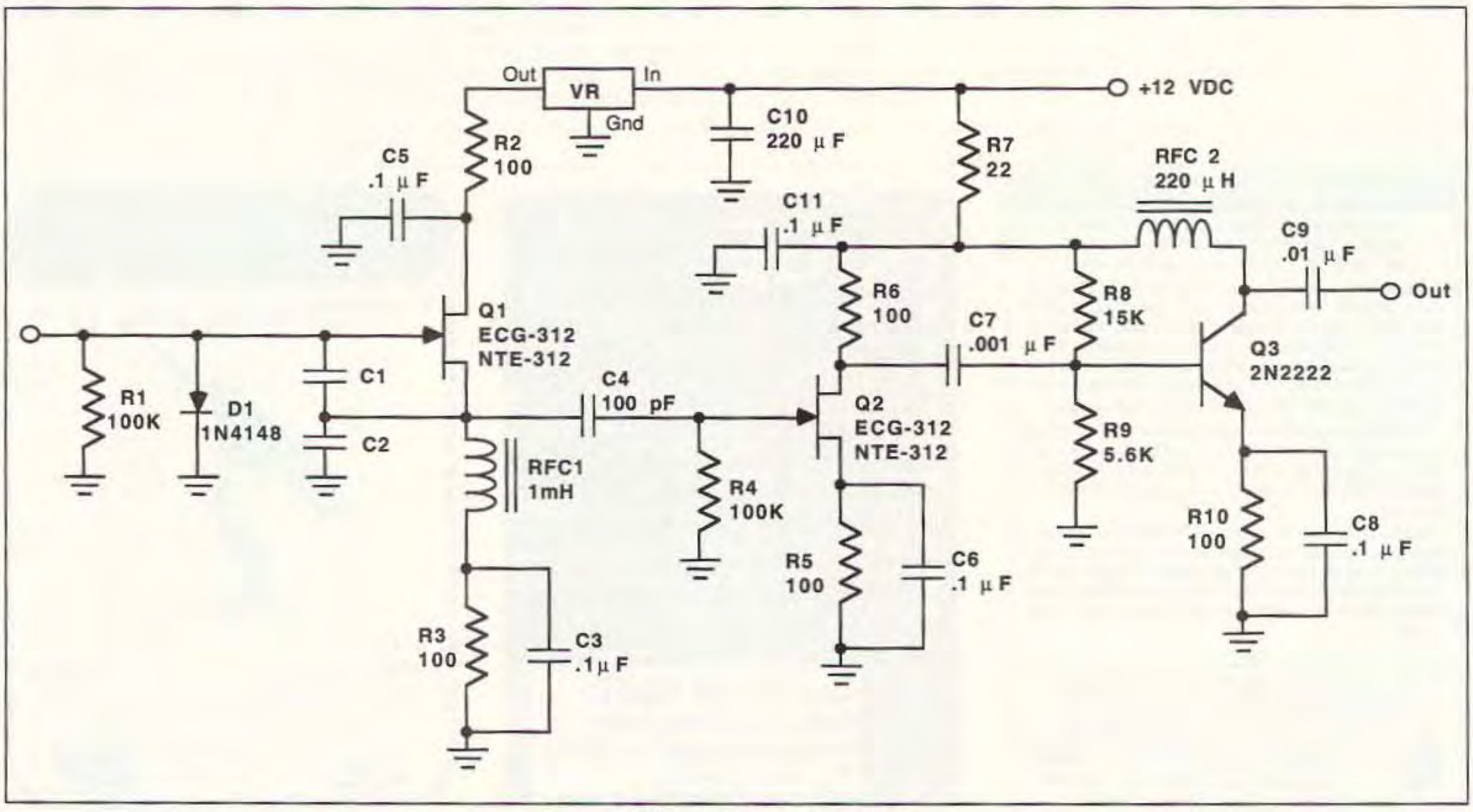

Figure 1. VFO circuit less the tuned circuits.

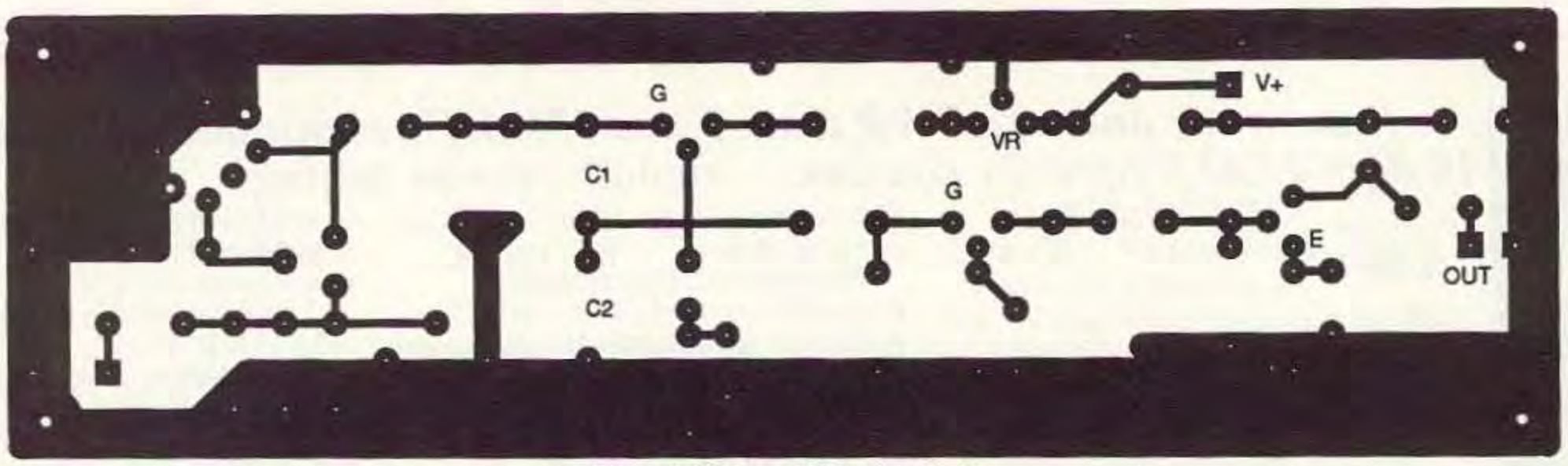

Figure 3. PC board foil pattern (1:1).

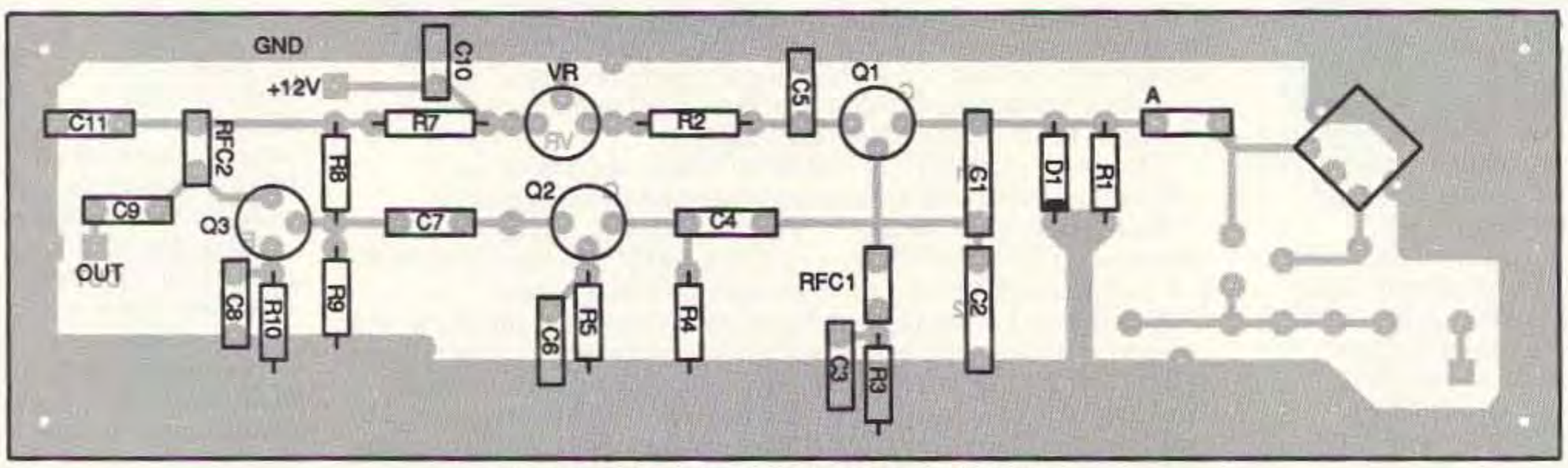

Figure 4. Parts placement for point "A" to the output.

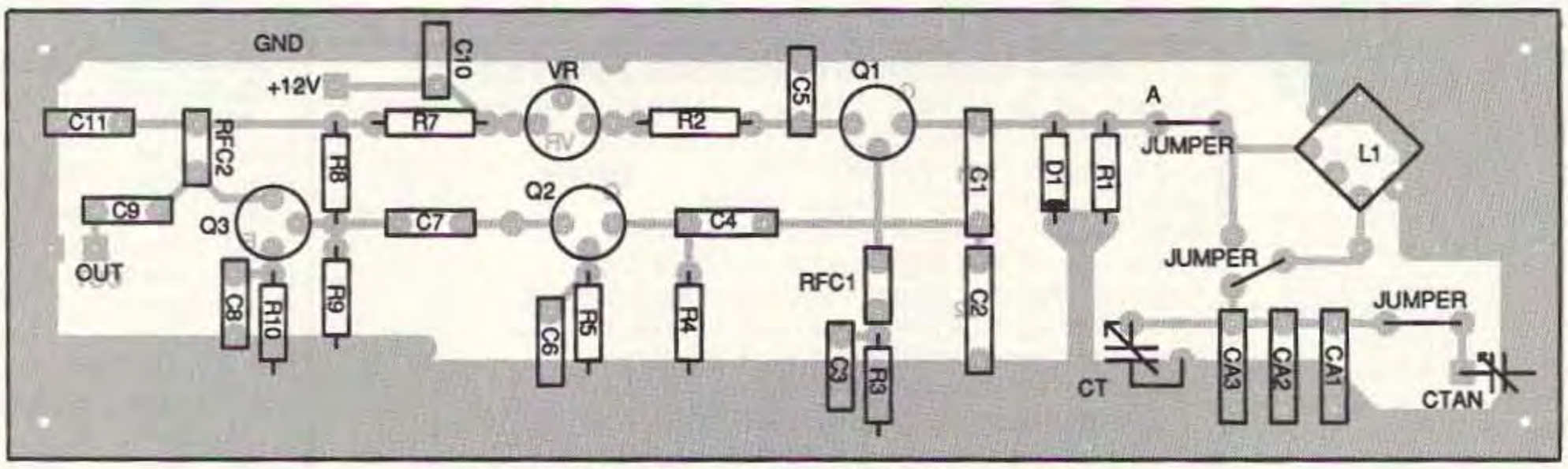

Figure 5. Parts placement with wiring for Clapp oscillator.

case. The total combination of all tuning capacitors should be about 200 ohms capacitive reactance, total. The feedback capacitors (C1 and C2) should have a reactance of approximately 50 to 100 ohms.

If you select the feedback capacitors (C1 and C2) incorrectly, then you may find either of two situations. First, the oscillation will abruptly cease at one or both ends of the tuning range. Second, the amplitude of the output signal drops to zero as the main tuning capacitor is tuned towards the high end of the range. All oscillators vary amplitude somewhat as the circuit is tuned, but when C1 and C2 are incorrect, the effect often drops rapidly as the main capacitor is tuned . . . reaching zero at some point.

There are two RF chokes used in this circuit (RFC1 and RFC2). The values shown are nominal values for high frequency applications, but variation will generally not harm the circuit's performance.

Figure 3 shows the foil pattern for the printed circuit board used with this project. You can make your own if you please, or order one for $14 either from me (POB 1099, Falls Church VA 22041) or from FAR Circuits (18N640 Field Ct., Dundee IL 60118). The parts layout for the printed circuit board is shown in Figure 4 for point "A" to the output.

The printed circuit board is set up for certain standard components. For RFC1 and RFC2, select components with 0.2" (5 mm) spacing between pins, such as the Toko size 8RB or 10RB coils. See the Digi-Key (POB 677, Thief River Falls MN 56701-0677; 1-800-344-4539) catalog for details on specific part numbers. Main tuning inductor L1 is selected from the Toko 10EZ, 10EZC, 10EZH, 10PA, or 10K size slug-tuned coils (again, see the Digi-Key catalog for part numbers for desired inductances). The trimmer capacitor, Ct, should be a 10 mm top-adjust type, such as the Sprague-Goodman FILMTRIM series sold by Digi-Key.

Configuring the printed circuit board for either the Colpitts or the Clapp oscillator depends on how the tuning components are wired on the board. Figure 5 shows the wiring for a Clapp (series-tuned) oscillator. The tuning capacitor, the trimmer and the fixed capacitors, plus inductor L1, are placed the same in both configurations. However, three jumpers are used in Figure 5 to make this circuit a Clapp oscillator.

Figure 6 shows the wiring for a Colpitts oscillator. One of the jumpers from Figure 5 is replaced with the DC blocking capacitor (Cc). The jumper from the fixed capacitors to the main tuning capacitor remains, and a new jumper is added from the bottom of L1 to ground.

Figure 7 shows the wiring for either Clapp or Colpitts cases where the tuning capacitor is series-connected with a small-value fixed capacitor. This configuration is often used for reducing the range of a variable capacitor to something required for a particular application. The total capacitance at any setting of the main tuning capacitor is:

$$C_{total} = \frac{(C_{BB})(C_{tun})}{C_{BB} + C_{tun}}$$

If you don't want to use the slug-tuned coil, but rather a toroid core inductor or air core inductor, then leave L1 off the board, and use the holes for the leads from the substitute coils.

Conclusion

This circuit makes a reasonable choice for many different VFO applications. It can be easily built, and is generally well behaved. Good luck. 73

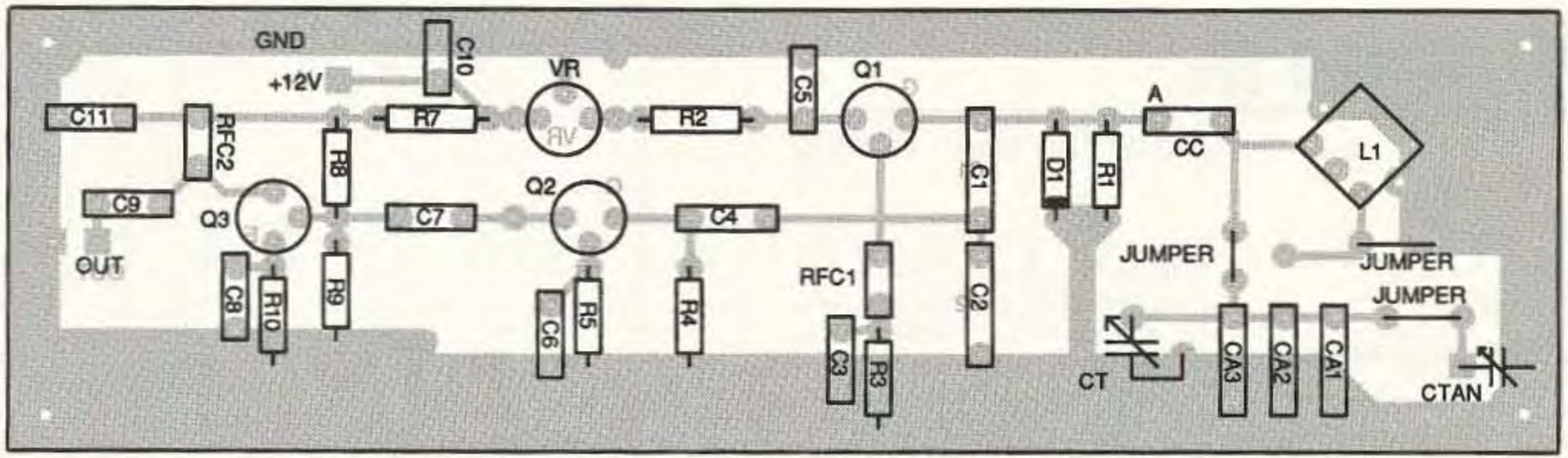

Figure 6. Parts placement with wiring for Colpitts oscillator.

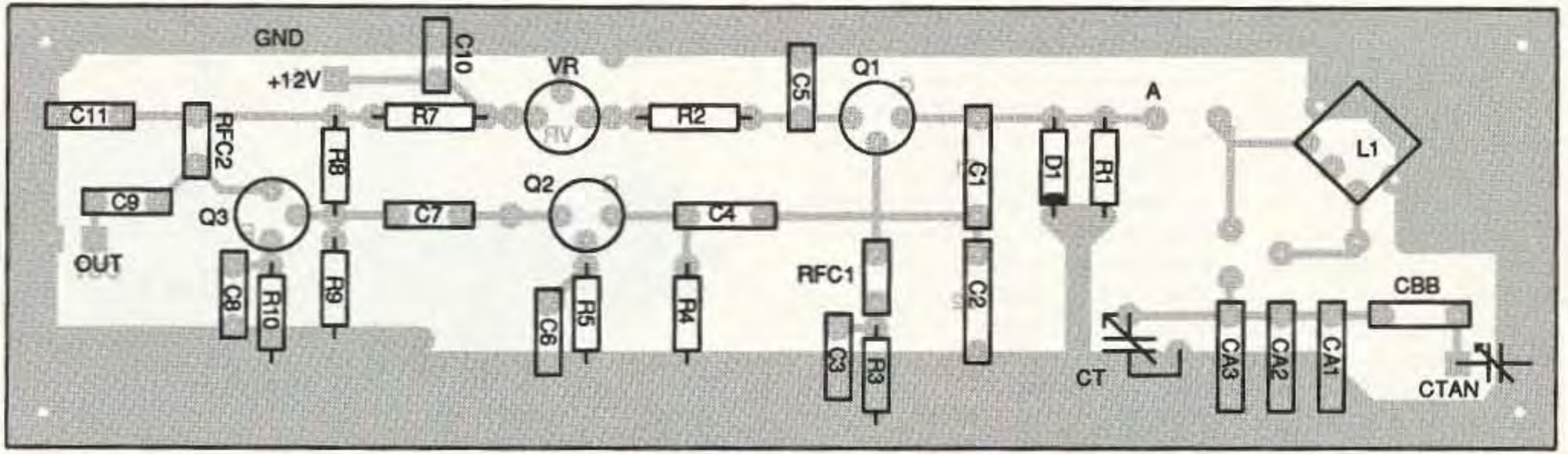

Figure 7. Parts placement with wiring for either Clapp or Colpitts cases where C_{tun} is in series with a fixed-value cap..