A License-Free Transmitter for 1,700 Meters

By Chuck Steer, WA3IAC

You may already know that the Federal Communications Commission has set aside a license-free band of frequencies on which anyone interested in radio communications can operate—whether or not he or she has a license. The frequencies lie between 170 and 190 kHz on the 1,700-meter band. The only restrictions are that the transmitting antenna must be 50 feet or less in length and output power must be 1 watt or less, not to exceed 50 microvolts per meter measured at 300 meters. Other than this, you're free to use any form of modulation and operate on the band for any purpose.

Though the above operating guidelines must be rigidly adhered to on the transmitting end, no restrictions are placed on the receiving end. For example, you can use any length antenna for maximum signal pickup. Unfortunately, most hf receivers don't tune down to where you want to listen. If you have a newer amateur radio rig that tunes from 150 kHz to 30 MHz, you're in business. However, if you have an older receiver that can't tune down to 150 kHz, you're not locked out of working this band. All you need is a converter that can go that low but put out a signal on 80 meters to which your receiver can tune. One such converter is listed in the Heathkit catalog; and there are other sources, too.

All converters cover from about 10 kHz to 500 kHz. With them, and using 80 meters as the output. Most hf rigs will allow you to read the tuned frequency directly from the dial. That is, if the dial reading is 200, for example, the tuned frequency is 200 kHz.

Since receivers or/and converters for the 1,700-meter experimenter band are readily available, the remainder of this column will be devoted to a low-cost transmitter you can build. This transmitter is built around two state-of-the-art components, one a CMOS integrated circuit and the other a VMOS power transistor. Parts cost should be less than $20—less still if you have a well-stocked spare-parts box.

As designed, the transmitter accepts a key for operating CW. However, with just a little bit of ingenuity, you can easily modify it to use a modulator for voice.

Transmitter Details

As shown in Fig. 1, two inverters in CMOS hex inverter *IC1* are cascaded to form a series oscillator that is crystal controlled by *XTAL1*. The frequency of the crystal determines the operating frequency of the oscillator and, hence, the transmitter. A third inverter is used for output buffering and inversion of the oscillator signal. The final three inverters in *IC1* are tied together in parallel to provide enough drive for VMOS output power transistor *Q1*.

CD4069 CMOS hex inverters are commonly available. If you can't locate a VN66AF or VN67AF VMOS transistor, you can contact Siliconix at 1327 Butterfield Rd., Suite 620, Downers Grove, IL

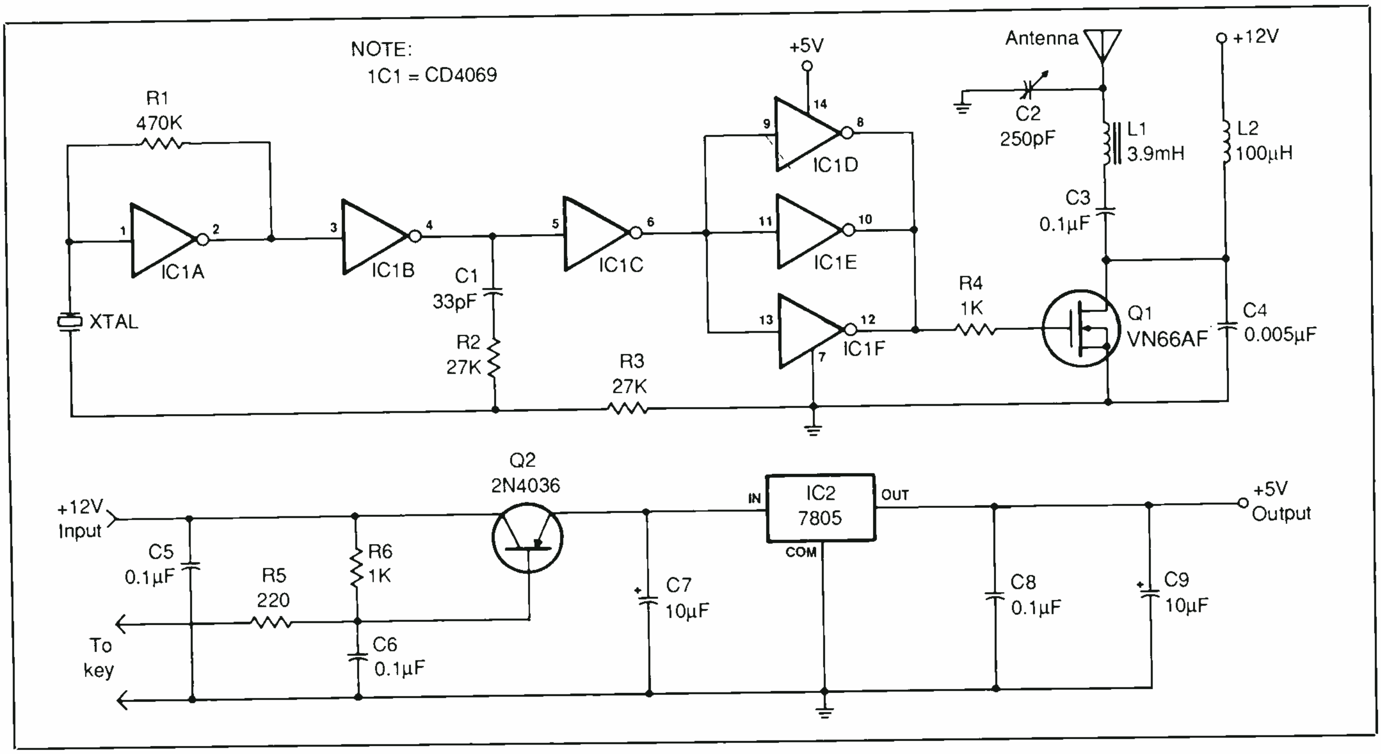

Fig. 1. Schematic diagram of transmitter and dc power supply.

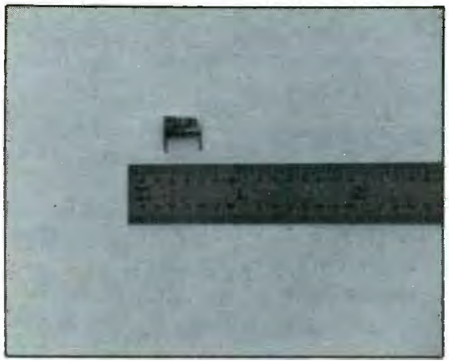

Fig. 2. The low-cost miniature crystal used in the transmitter's oscillator.

60515 or GE Semiconductor Sales, One Micron Dr., Research Triangle Park, NC 27709 (tel. 919-549-3100) and ask for a location of a distributor in your area.

A CX-1X type crystal that's designed for rapid start-up and high reliability in a series oscillator is used in the transmitter's oscillator. Most crystals for this band cost about $20. However, Statek (512 N. Main St., Orange, CA 92668; tel. 714-639-7810) makes the miniature size one shown in Fig. 2 that's ideal for this application and costs only $8.

Component values given in Fig. 2 are for a frequency range of 120 kHz to 199.9 kHz. This will keep the transmitter within the range specified by the FCC for the experimenter band, assuming you use a crystal of appropriate frequency.

Power for the transmitter's circuit comes from a conventional regulated dc supply. This supply starts with 12 volts dc at its input, which can be any 12-volt dc source from a simple battery arrangement to an automotive electrical system to a dedicated ac-operated power supply. The 12 volts is used directly to power the *Q1* VMOS amplifier stage. The 12 volts is also delivered through series-pass transistor *Q2* to voltage regulator *IC2*, which outputs +5 volts to power the *IC1* CMOS section of the transmitter.

Keying for the CW transmitter is provided by biasing *Q2* on and off with a standard Morse key. The transistor can handle 60 mA continuously, which is more than enough current to run the circuit at full legal output. Closing the key's contacts biases on *Q2* to power *IC1*, while opening the contacts cuts off the transistor.

Building the Transmitter

Though the transmitter can be built using perforated board and point-to-point wiring (an early version I built in this manner still works), it is far easier to use printed-circuit board construction. An actual-size etching-and-drilling guide for the board is shown in Fig. 3.

Reactance of the crystal is capacitive in any series oscillator arrangement. Therefore, circuit layout requires care to avoid having circuit capacitance create a low-Q feedback path that can degrade oscillator performance. Any large value of stray capacitance will reduce loop gain and lower circuit stability. In a pc layout, no circuit traces should be longer than 1 inch and none should be paralleled. As you can see from my pc guide in Fig. 3, I strayed a bit from good layout practice. However, I built two different versions of the basic transmitter circuit using this guide and have experienced no ill effects.

Wire the board exactly as shown in Fig. 4. Use a socket for IC1 and make sure that the electrolytic capacitors, ICs and transistors are properly oriented before soldering them into place. Also, install 2-inch insulated hookup wires at the locations labeled KEY, ANTENNA, +12V INPUT and GND; the free ends of these wires will be connected later.

No heat sinking was used in my transmitter prototype for *Q1*, though the VMOS transistor does run warm. During one test of the transmitter, I used an XR2209 as a 1-Hz, 50-percent duty cycle oscillator to see if 2N4036 transistor *Q2* or VN66AF VMOS transistor *Q1* would become hot in operation. Running the circuit in this manner for about 30 minutes yielded very good results.

The Antenna

As mentioned earlier, antennas for transmitting on the 1,700-meter experimenter

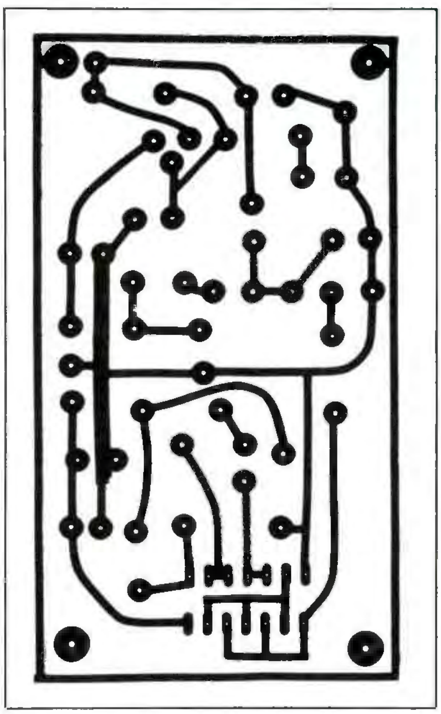

Fig. 3. Actual-size etching-and-drilling guide for fabricating a pc board.

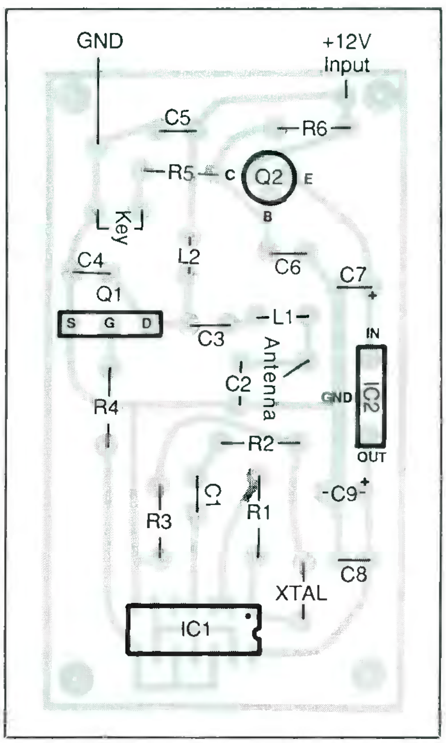

Fig. 4. Wiring diagram for pc board.

band of frequencies must be no longer than 50 feet, though those for receiving can be any length you desire. The easiest way to go in a transmit/receive system is to use a single 50-foot maximum antenna suitable for transmitting and receiving. This will keep the antenna to legal length, though reception might suffer.

An alternative is to use a loop antenna, which some enthusiasts use to receive on 160 meters. If you go this route, you'll have to tune the antenna for vlf reception. A Navy direction-finding antenna might also be okay to use as-is.

An active antenna is a good choice. You can get one that operates on 1,700 meters from MFJ and Palomar, among others. Not all active antennas will be suitable for use on the 1,700-meter band. For example, Heath's covers 300 kHz to 30 MHz. So keep this in mind when you're shopping for an active antenna.

Best results are obtained with a dedicated 50-foot wire for transmitting and any other antenna that will provide maximum signal pickup for receiving. Since a long-receiving antenna for 180 kHz at ¼-wavelength will be 1,300 feet long, it's better to use a base-loaded inverted L or a top-loaded vertical antenna for receiving.

Tuning & Testing

With the transmitter powered, the first thing to do is use an oscilloscope or frequency counter to check the oscillator to ascertain that it's operating. If you don't have access to either instrument, don't despair; you can listen for the oscillator signal with a nearby receiver or converter/receiver arrangement tuned to the proper frequency for the tone that indicates proper operation.

With an SWR or watt meter in the antenna line, adjust 250-pF trimmer capacitor *C2* for maximum indicated output. Then check the current in the antenna circuit to be sure that it doesn't exceed 100 mA. Remember that power is equal to voltage times current.

When you're satisfied that the transmitter is operating as it should and is properly tuned, house it inside a suitable enclosure. As shown in Fig. 5, this can be an ordinary plastic project box with a removable aluminum panel. Drill holes in the panel for and mount a phono jack for the antenna input and a suitable connector for the 12-volt dc power source you plan to use with the transmitter. Drill a third hole, in one of the box's walls, and mount in it a phone jack for the key you'll be using.

Use the circuit-board assembly as a template to mark the locations of its mounting holes on the floor of the box. Drill the holes at the marked locations and mount the board with spacers and machine hardware. Finish up by connecting and soldering the free ends of the wires coming from the circuit board to the jacks, referring to Figs. 1 and 4 for details. **ME**

Fig. 5. The finished 1,700-meter experimenter's transmitter.