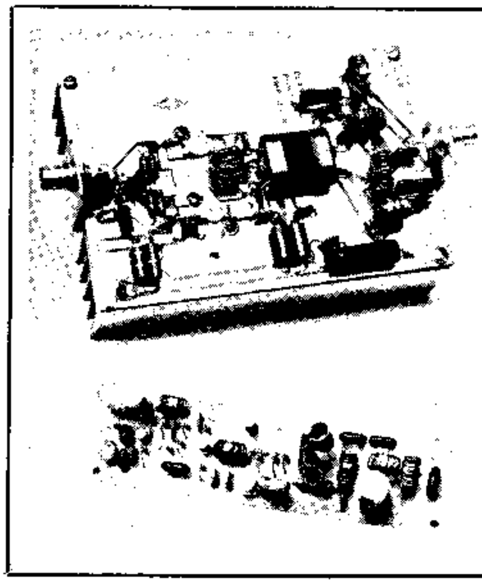
A VXO CW Rig for 30 Meters

Does your present transmitter lack 30-meter provisions? Have you wanted to try this interesting amateur band? Here are the details for building your own solid-state transmitter — QRP or 60 watts.



By Doug DeMaw,* W1FB

Have you been reluctant to spend money on a new transceiver or transmitter, even though your present rig does not permit you to work 10.1 MHz? Frugality in these troubled economic times has made many of us a trifle "slow on the draw" when it comes to investing in hobby types of items. But, we can build a cw transmitter inexpensively and quickly if we wish to enjoy the interesting characteristics of the new 30-meter band. A general-coverage receiver can be used to receive on 10.1 MHz, or we might consider building a simple 30-meter converter for use with an existing ham-band-only receiver. This article describes a transmitter and includes a suggested design for a little receiving converter.

What's 30 Meters Like?

We examined the 30-meter band in general terms last month in *QST* while discussing various simple antennas for that band.[1] But briefly, it is a spectacular crossbreed of the 40- and 20-meter bands in terms of propagation. I have seldom found 30 meters closed because of poor propagation conditions. QRN is lower than on 40 meters, but slightly more prevalent than on 20 meters. Occupancy is very low, owing to the lack of contesting and "award chasing." Therefore, QRM is seldom a problem. I find 30 meters the best of the hf bands for keeping schedules beyond a 300-mile distance. Low power seems to do as well as the legal 250-W dc input limit. Many amateurs are found on the band with QRP rigs, and I have had no trouble copying stations with 1- or 2-W signals. One fellow I worked was using a modified Heath HW-7 QRP transceiver, and he was running 0.5 W. Despite the 300-mile distance, his signal was S 8, and he was using a dipole in his attic! Be sure to remember the band limits and authorized U.S. segments: 10.100 to 10.109 MHz and 10.115 to 10.150 MHz. *Do not operate from 10.109 to 10.115 MHz!*

The Transmitter Exciter Module

If you're a QRP enthusiast, it is likely that the circuit of Fig. 1 will appeal to you. It is simple and can be built in an evening. Pc boards and a parts kit are available.[2] Power output will be on the order of 1-2 W, depending on the characteristics of the transistors used from Q1 through Q3. If you are interested in having more available output power, the power-FET amplifier described earlier in *QST* can be connected to the output of this exciter/transmitter.[3] If that is done, the FETs can be changed from the MRF138s specified in the article to Motorola MRF171s, which are more readily available than the former ones. The '171 is rated at +65 V maximum, V_{DSS} and an I_D of 4.5 A continuous. Maximum power output is rated at 45 W per device from 2.0 to 200 MHz. This transistor is directly interchangeable with the MRF138.

A VXO is used in the circuit of Fig. 1. This frequency element provides excellent stability and ample frequency swing for the 30-meter band. Q1 functions as a Colpitts oscillator with feedback from source to gate. The crystal is "rubbered" (or pulled) by means of L1 and C1. A 10-kHz swing should be easy to obtain when using a quality AT-cut plated crystal in an HC-6/U style of holder. Surplus FT-243 crystals are not recommended because they may be sluggish and will not provide ample frequency shift when C1 is tuned through its range. Output for Q2 is taken from the source of Q1.

Q2, the buffer amplifier, operates Class A and is broadbanded. It has a gain of approximately 12 dB and helps to isolate the final amplifier, Q3, from the oscillator. This eliminates potential problems with chirp on the cw note. Also, Q2 gives the signal sufficient boost to drive the power FET, Q3. A broadband transformer, T1, provides the coupling from the collector of Q2 to the gate of Q3.

R1, the emitter-bias resistor of Q2, can be changed in value to control the output level of the exciter. If the little transmitter will be used as an exciter for the 60-W power-FET amplifier mentioned earlier, R1 will need to have increased resistance to limit the Q3 output to approximately 0.5 W. If not, the exciter will drive the power amplifier beyond the safe limits. You may want to add a 1-kΩ potentiometer between the low end of R1 and ground for use as a drive control.

A Siliconix VN67AF power FET is used at Q3. I chose this device because it is inexpensive and requires very little excitation to develop the desired power output. It is biased for Class B linear service, with a forward gate voltage of approximately 1.2. Class A operation, and greater linearity, can be had by changing the value of R2 to increase the gate bias to 3 V. This will lower the drive requirements from Q2. However, the idling current of Q3 will be greater with increased gate voltage.

T2 is also a broadband transformer. It transforms the Q3 drain impedance to that of the harmonic filter, FL1 (50 ohms). A simple half-wave filter ensures spectral purity, with all spurious responses being −40 dB or better, as required by FCC regulations. When driving a successive

[1]Notes appear on page 34.

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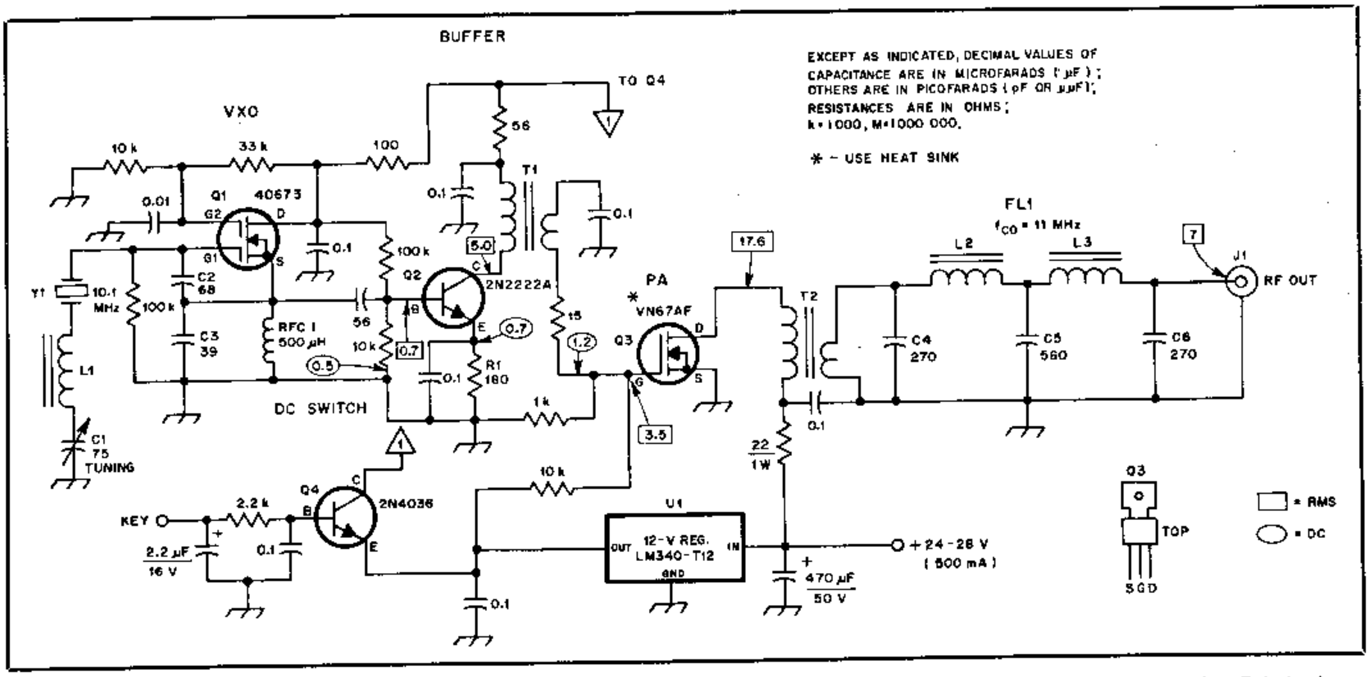


Fig. 1 — Schematic diagram of the 30-meter QRP transmitter/exciter. Fixed-value capacitors are disc-ceramic unless noted otherwise. Polarized capacitors are tantalum or electrolytic. Resistors are carbon-composition types, ¼-W, unless indicated differently.

C1 — Miniature air variable, panel mounted.
C2-C6, incl. — Silver mica or polystyrene.
J1 — Coaxial female connector of builder's choice.
L1 — 12-µH inductor. 50 turns no. 28 enam. wire on T50-2 toroid core.
L2, L3 — 0.72-µH inductor. 13 turns no. 24 enam. wire on T50-6 toroid core.
R1, R2 — See text.
T1 — Broadband transformer. Primary has 12 turns no. 26 enam. wire on an FT50-43 ferrite toroid. The secondary has six turns of the same type of wire.
T2 — Broadband transformer. Primary contains 15 turns no. 24 enam. wire on an FT50-43 ferrite toroid. Secondary has six turns of the same type of wire.
Y1 — Fundamental crystal, type AT in HC-6/U holder. Order for center of desired 10-kHz tuning range, 30-pF load capacitance.

power amplifier with the circuit of Fig. 1, clean excitation energy will be beneficial in assuring clean output from the power amplifier. It is always a good objective to supply the purest of driving power to any stage of a transmitter.

A 24-V power supply was chosen to permit Q3 to develop the desired output power easily. Although most power FETs will operate at low voltages, such as 12 V, they saturate readily at voltages below the rated potential. That is, a 28-V FET will deliver only a fraction of its rated power at 12 V. A VN46AF (available at Radio Shack stores) can be used at Q3 if we reduce the supply voltage to 18 or less. Unfortunately, the VN67AF contains a built-in Zener diode from gate to source, which can be shorted if the peak driving voltage to the gate is excessive on the negative half cycle. When this happens, the FET junction will become shorted, and that will be the end of our transistor! The safe gate swing for a VN67AF will not be exceeded in the circuit of Fig. 1.

A three-terminal regulator, U1, provides the operating voltage (regulated) for Q1, Q2, Q4 and the gate of Q3. This section can be eliminated if separate power supplies (12 and 24 V) are available, or if we choose to operate Q3 at 12 V. This reduced drain-source voltage at Q3 will require a different resistance value for R2 if we are to have the desired +1 to +3 V of forward gate voltage. Similarly, the turns ratio of T2 will need to be modified to accommodate the new drain impedance. The approximate impedance is obtained from $V_{DD}^2/2P_o$, where V is in volts and P is in watts.

Keying of the exciter is accomplished by means of Q4, which is a pnp dc switch. When the base is keyed (grounded) the transistor conducts, thereby allowing the +12 V to reach Q1 and Q2. This turns on the transmitter during key-down periods. Since Q3 operates in a linear manner, the keying is not hard (clicky) as it might be when keying the drive to a Class C amplifier. Two capacitors and a 2.2-kΩ resistor form a shaping network in the base lead of Q4. This aids in rounding off the sharp trailing edge of the cw waveform. Increasing the value of the 2.2-µF input capacitor at Q4 will further "soften" the cw note. If break-in delay is desired for the keying circuit, the module described in an earlier *QST* article can be used.[4] It is designed to prevent "hot switching" the final amplifier, which in turn protects the PA stage from no-load (momentary) damage. By avoiding hot switching of the PA (no antenna attached as the changeover relay cycles from receive to transmit), we also prevent unwanted spurious "blurps" from appearing on the air. Some commercial rigs are offenders in this regard. The referenced QSK module has switching capability for muting a receiver. It also features adjustable time constant for con-

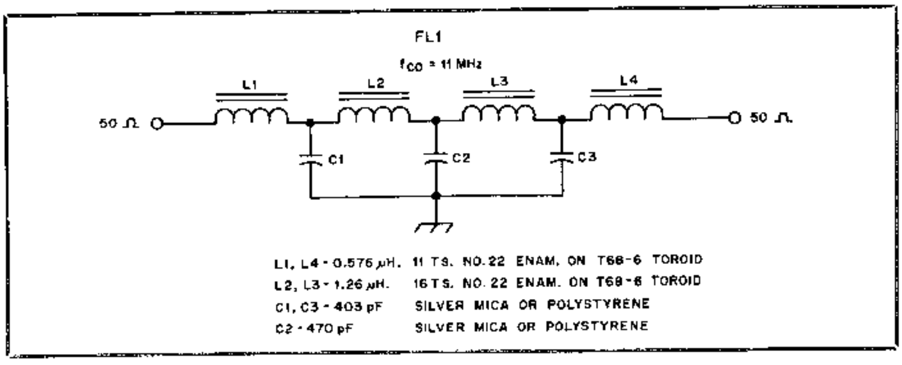


Fig. 2 — Details for modifying the power MOSFET amplifier of note 3 for use on 30 meters.

trolling the relay drop-out time. It can provide full QSK if a reed or mercury-wetted relay is used in place of the relay specified.

Interface to the Power-FET Amplifier

The exciter and the amplifier are designed for connection to 50-Ω loads. Therefore, we can use a short length of 50-Ω coaxial line to join the modules (output of the exciter to the amplifier input). A 28-V, 5-A regulated dc supply will handle the entire transmitter nicely. Many such power supplies are available from surplus houses at reasonable cost. Be sure to check the flyers and catalogs if you don't own a 24- or 28-V power supply.

We must permit only enough drive from the exciter to develop 60 or fewer watts of amplifier output power into a 50-Ω load. This will be on the order of 0.5 to 0.75 W typically. The +24 or +28 V line to the 60-W amplifier can be left operational at all times. This will avoid the need to include the amplifier in the T-R loop. The antenna lead will need to be switched, however.

Minor changes are necessary in the amplifier discussed in note 3. The only modification for 30-meter use involves changing the constants in the output filter, FL1 (Fig. 4, page 27, March 1983 *QST*). Fig. 2 of this article contains the coil and capacitor data for 30 meters. C1 and C3 may be formed by placing a 390- and a 12-pF capacitor in parallel at each spot in the filter. The powdered-iron toroid cores are available by mail from Amidon Associates, Palomar Engineers and RadioKit (see *QST* ads). The entire amplifier kit or a composite unit (also a kit) containing the amplifier and the exciter of Fig. 1 can be obtained from the supplier in note 2.

Receiving on 30 Meters

We mentioned earlier a suggested design

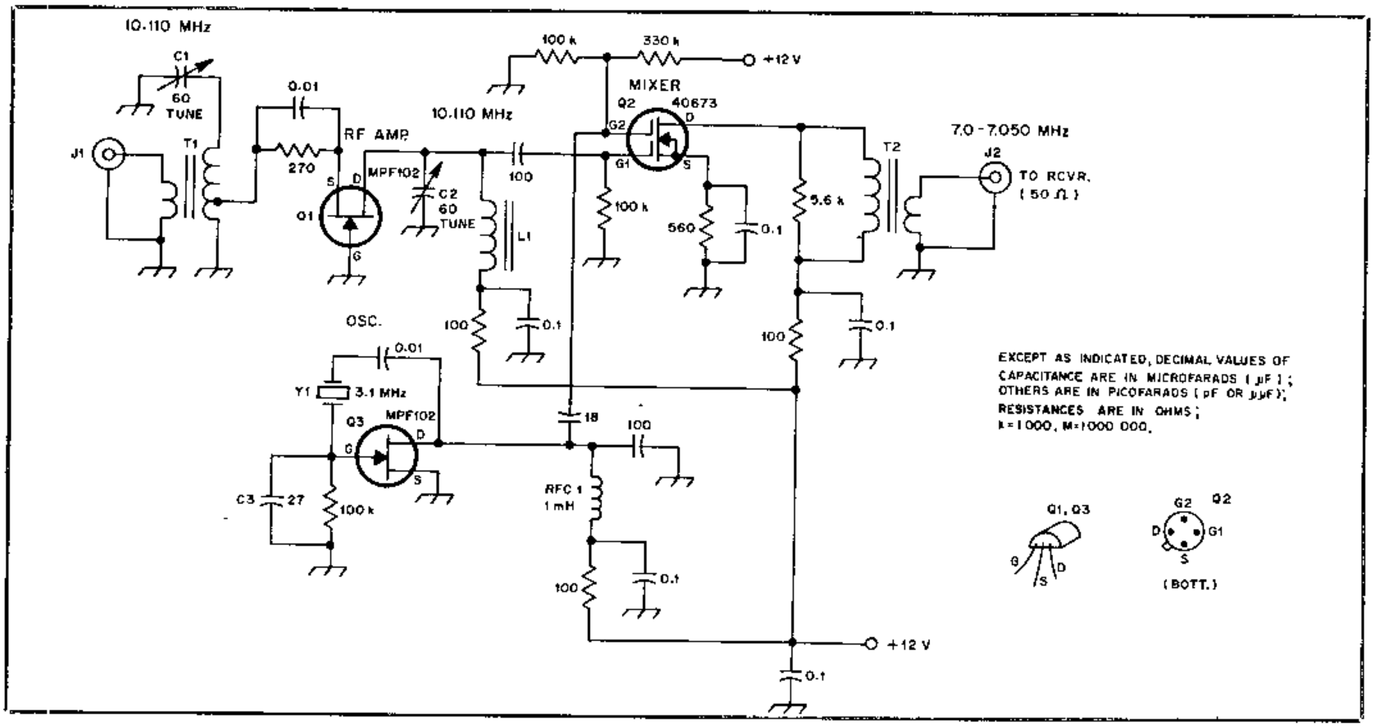


Fig. 3 — Suggested circuit for a simple 30-meter converter. The i-f is 7.000 to 7.050 MHz. C1 and C2 are mica compression trimmers or miniature ceramic or polystyrene trimmers. See text for C3. J1 and J2 are phono jacks. L1 is a 6-μH inductor (38 turns no. 30 enam. wire on a T50-6 toroid core). T1 has the same winding on the secondary as L1. Tap the source of Q1 eight turns above the grounded end. The primary has three turns of no. 30 wire. T2 has 15 primary turns of no. 24 enam. wire on an FT50-43 toroid. The secondary contains two turns of no. 24 wire.

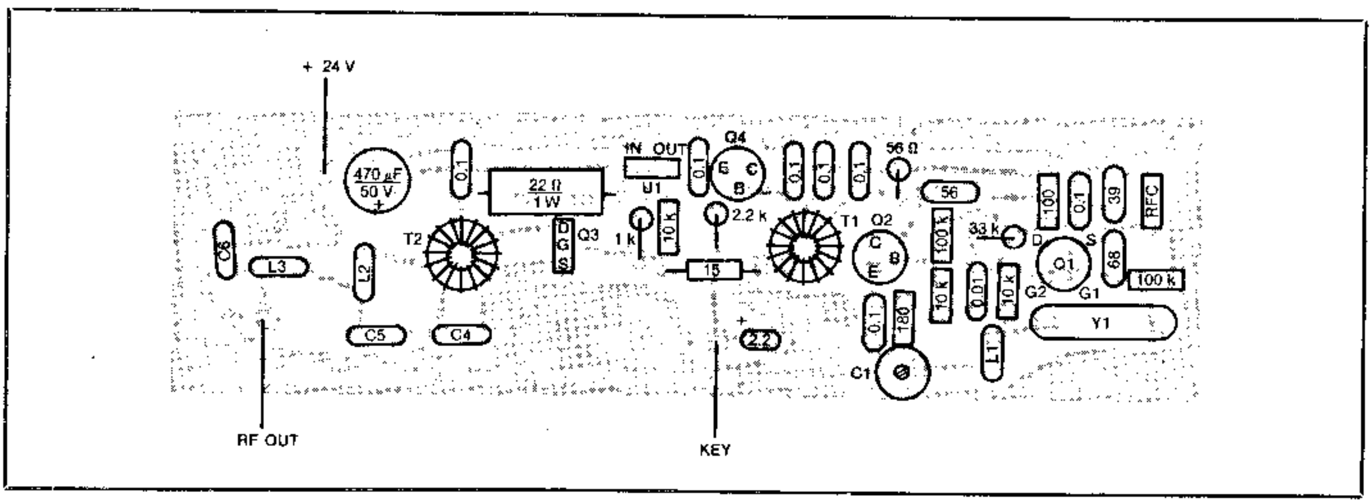


Fig. 4 — Parts-placement guide for the 30-meter exciter, as viewed from the component side of the pc board. See Hints and Kinks, this issue, for the etching-board pattern.

for a 30-meter converter. There are many designs to be found in the amateur literature, most of which could be modified easily to 30 meters. But, in the event you are not sure of what is required to perform proper alterations for a new operating frequency, the circuit of Fig. 3 should be entirely suitable. It has been proven during use on many of our hf bands.

The converter can be fed to a receiver that tunes the 40-meter band. A 3.1-MHz crystal at Y1 of Fig. 3 enables us to tune 10.100 MHz at 7.000 MHz on the receiver. When we tune our receiver to 7.050 MHz, we will be listening to the high end of 30 meters (10.150 MHz).

Q1 provides some 10 dB of gain as a common-gate rf amplifier. C1 and C2 are adjusted for a peak response at the center of the 30-meter band. Or, if you are interested mainly in the low segment of the band, you may wish to peak the trimmers at 10.105 MHz.

The mixer has a broadband output circuit to permit coverage at the i-f without need to retune the mixer output as the station receiver is tuned from 7.0 to 7.050 MHz. A 5.6-kΩ resistor is used across the primary of T2 to aid in IMD reduction and to establish a fixed-value impedance for the Q2 drain circuit.

A Pierce oscillator is used at Q3. A load capacitance of 30 pF is suggested when ordering Y1. If you use a surplus crystal and find it a bit sluggish with regard to oscillation, try increasing the capacitance of C3 slightly. This is a feedback capacitor.

Construction Data

Fig. 4 contains a parts-placement drawing of the 30-meter exciter. A scale template for the pc board appears in Hints and Kinks in this issue. Layout and construction information for the 60-W power-FET amplifier was provided in March 1983 *QST*. There is no layout data for the suggested converter. You may lay it out on perforated board, or try your hand at pc-board layout and etching. Check with the supplier in note 2 for the availability of converter boards and kits.

Closing Comments

Adventure is awaiting you on 30 meters. That, plus the thrill of going on that new band with a homemade station, will make these projects worth your while! Perhaps you will choose to start operation at the QRP level. It is logical that any newcomer would prefer to assess the band for interest and advantages before getting tooled up for the 60-W power level. That part of the project can come later if you find the band to your liking. Whatever the situation, good luck on 10.1 MHz!

Notes

[1]D. DeMaw, "Building and Using 30-Meter Antennas," Oct. 1983 *QST*.
[2]Circuit Board Specialists, P.O. Box 969, Pueblo, CO 81002.
[3]D. DeMaw, "Go Class B or C with Power MOSFETs," March 1983 *QST*.
[4]D. DeMaw, "20-Meter Hamcation Special," Nov. 1982 *QST*.

Strays

THANKSGIVING — A SPECIAL EVENT

☐ It all started in 1980 when a member of the Whitman (Massachusetts) ARC approached me and several other members of the club and asked a simple question: "With all the early-American historical sites around us, why haven't we done anything to bring this to the attention of the rest of the world?" None of us had ever operated a special-event station. The closest any of us had come to that was Field Day, and what we learned from that over the years really paid off.

With this thought in mind, we contacted the administrators of Plimoth Plantation, a nonprofit living history museum in Plymouth, Massachusetts, and related our ideas to them. Their response was overwhelming, and they welcomed us with open arms. It turned out we could operate from inside the museum library. Considering the operating date was set for Thanksgiving Day and the familiar adverse weather conditions of November, it seemed like the ideal place to operate.

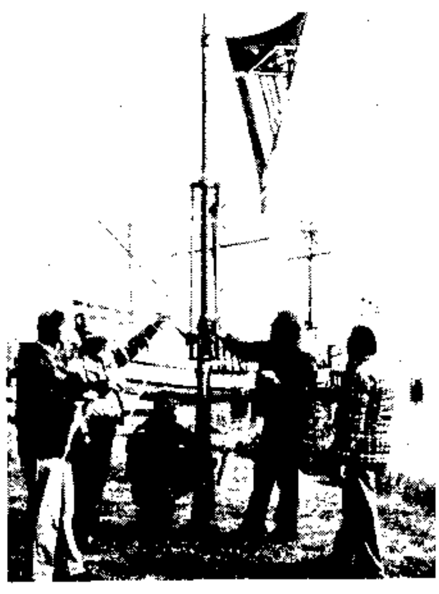
We decided to use 15 meters for distance and 40 meters for regional coverage. We had a dipole for 40 meters, a 3-element Yagi for 15 meters and an old (but in top shape) military, crank-up 50-foot field tower. The weekend before the operation, five of us went to the Plantation to set up the antennas. This is when our Field Day experience particularly paid off, as we had to brave 40-mile-per-hour winds and a downpour to get everything up and properly guyed.

On Thanksgiving Day, we worked just about every state in the U.S., all through Europe and parts of the Middle East and Africa. A special QSO occurred between a ham in Plymouth, England, and our Plantation Station.

The second year of operation, conditions were poor. We did manage to work as many stations as the year before, but our DX total was only a dozen or so, with only a few in England.

This year, with propagation rapidly declining, we are going to expand our operations to include 20 meters and limited 2-meter operations (see Special Events, this issue, for more details).

This year's event will also be supported by members of the Plymouth (Devon, England) Radio Club, operating G3PRC from a site overlooking Plymouth Sound, from where the Pilgrims began their journey aboard the *Mayflower* in 1620. We are looking to break a 1000-QSO total in one day this year, so put on your rigs and be part of the holiday celebration! — *Jim Russell, WB1CNM, Brockton, Massachusetts*



Whitman (Massachusetts) ARC members stake a claim for Amateur Radio at Plimoth Plantation prior to their Thanksgiving Day operation there. Pictured (l-r) are WA1FSO, W1TC, WB1CNM, KA1CZS and KJ1X. *(photo courtesy WB1CNM)* reduction adapter (for less than $2) to cure this problem. I used a ¼-inch phone plug, an enclosed jack and an angle bracket.[6] The bracket can be aluminum or steel, 1½ × 1 × ¾-1 inch wide.

Drill holes in the bracket as indicated in Fig. 5. The TS-130 has a screw 1½ inches from the front of the cabinet top that I used to mount the L bracket. If you are adding this drive-reduction unit to another rig, you may have to drill a hole in the cabinet to mount the bracket. I used a small piece of double-sided tape under the front of the bracket. Mount the phone jack to the angle bracket and insert the plug. Now stretch a wide rubber band over the phone-plug barrel and around the tuning knob.

You can use the phone plug for a tuning knob, or if you want a larger diameter knob, solder a short piece of ¼-inch-diameter copper tubing to the phone-plug terminals. Replace the barrel on the plug and secure a larger control knob to the extension.

The tuning rate is much slower now, but if I want to make a large frequency change I can still use the main tuning knob. — *Larry Dougherty, KN8I, Yale, Michigan*

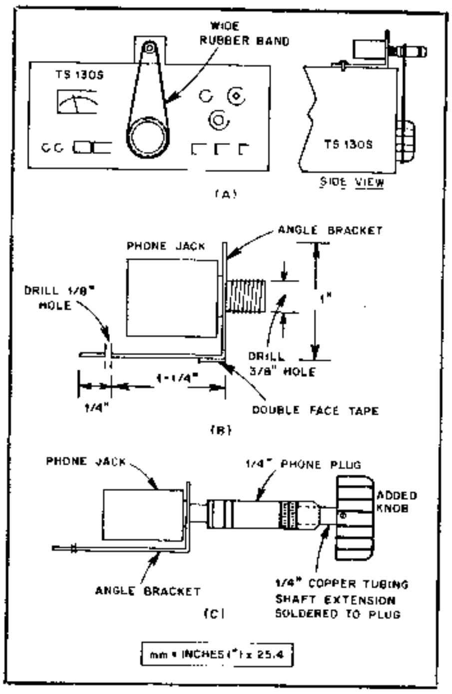


Fig. 5 — At A are shown the mounting details for a tuning-dial-drive reduction system used by KN8I. The dimensions for the mounting bracket are given at B. One method of adding a larger-diameter tuning knob is shown at C.

FASTER AGC RELEASE TIME FOR THE TEN-TEC ARGOSY

☐ I have found my Ten-Tec Argosy to be a fine all-around rig. I especially like the full QSK feature. However, I believe the agc release time is too slow for cw operation. I prefer the agc to release a bit faster, even for phone work. I changed a single capacitor in the agc circuit to provide a release time more to my liking.

Remove the top cover and locate the I-F/AF circuit board. It is the large board just behind the front panel. Find C12, a 33-µF capacitor at the center rear part of the board. This capacitor is connected from the base of Q4 to ground. The rate of discharge for this capacitor controls the agc circuit release time.

Unplug all cables going to the I-F/AF board, remove the five screws that fasten it to the chassis and lift the board out. Remove C12 and replace it with a 5- to 10-µF capacitor rated at 16 V or higher. I prefer the 5-µF unit for a faster release time, but you may want to experiment. Reinstall the board and connect the cables.

I find the cw operation of my rig to be much smoother after this change. I also notice that I am able to copy more weak stations than before because strong nearby signals don't limit the receiver gain as much. — *Bill Scott, AG0O, Elizabeth, Colorado*

2-METER AMPLIFIER INSTABILITY

☐ I built a solid-state amplifier to boost the 1.5-W output from my 2-meter hand-held transceiver to about 30 W. The amplifier suffered occasional instability problems, depending on the lengths and positions of the rf input and output cables. The measured SWR, both into and out of the amplifier, was less than 1.5:1.

Some research led me to the conclusion that my problems were caused by rf energy being conducted on the outside of the RG-58/U coaxial-cable braid. The ground connections for the transceiver, amplifier and amplifier power supply were separated from each other by significant fractions of a 2-meter wavelength. There was no good ground reference for the rf energy. The chassis of each unit could "float" above rf ground, inducing rf currents to flow along the outside of the coaxial-cable shield braids. My amplifier was affected in unpredictable ways by these currents.

I found a simple cure for the problem. I looped each rf cable twice through an Amidon FT-114-43 ferrite torroid. My calculations indicate that this effectively adds about 2.4 µH of inductance in series with the outside of each braid. The result is an rf choke with over 2200-ohms reactance at 2 meters. I chose type-43 material for high loss above 100 MHz, so the toroid dissipates rf energy like a ferrite bead does. This combination of effects has completely cured the instability problems with my amplifier, regardless of cable length or orientation. — *Kenneth H. Kerwin, II, K6UXO, Londonderry, New Hampshire*

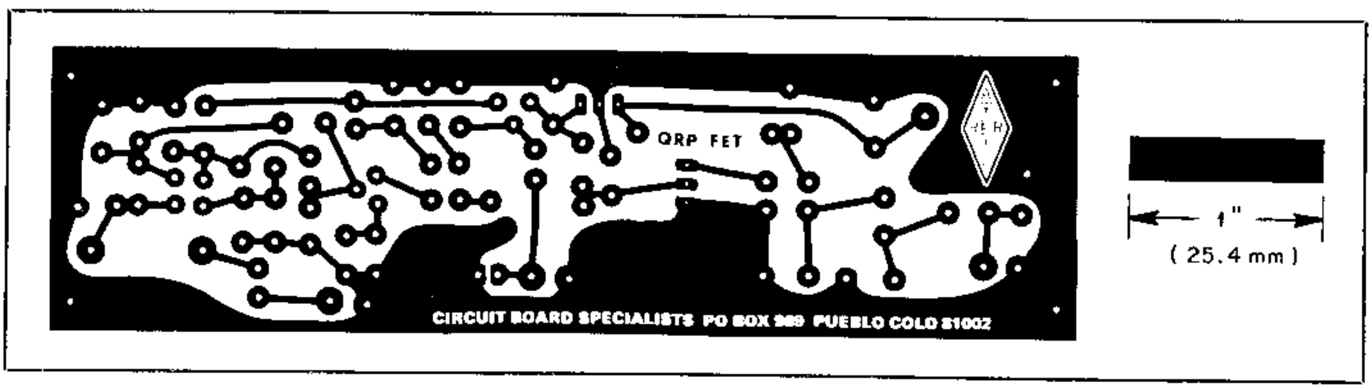
USING RUB-ON ETCH-RESIST TRANSFERS

☐ Here are a few suggestions for those who have had problems with rub-on etch-resist transfers coming loose. First, the board must be very clean. Then, warm the board before applying the transfers. I warm small boards by placing them on the shade of my desk lamp for a few minutes. Apply the transfers to the warm board, and burnish them well. Rewarm the board if it cools off during circuit layout. After all of the circuit is laid out, warm the board for several hours and then burnish all of the transfers again. Using a small piece of paper towel, gently wipe the board to remove any fingerprints or other dirt.

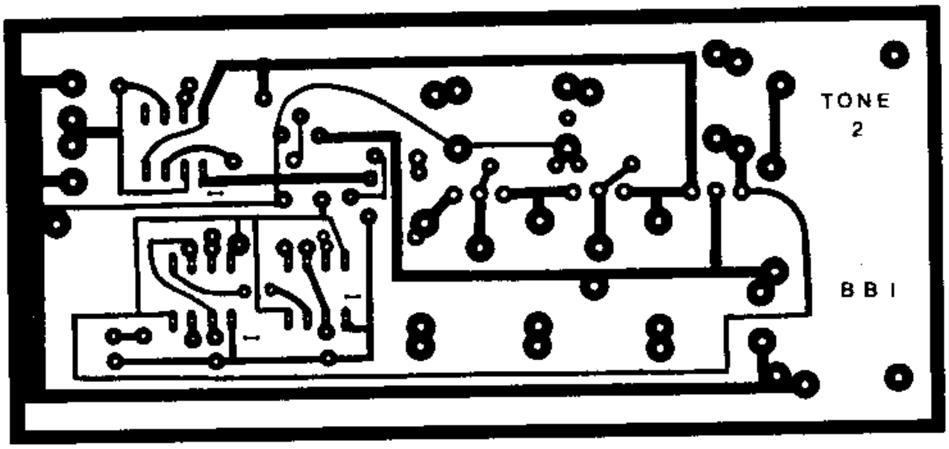
I have not had any problems with transfers coming off in the etchant since I began using this method. The warming technique also works well for applying panel-marking rub-on labels. — *J. T. Miller, N6BM, Ukiah, California*

A TUBING CUTTER AND COAXIAL CABLE

☐ I read with interest the hint by Kirk Carter in the September 1982 Hints and Kinks column about using a tubing cutter to prepare RG-8/U coaxial cable for a PL-259 connector. I have used a method like this for many years, and find that it works well. But I would add a word of caution. Before you use the tubing cutter to cut the tinned braid, be sure the cable has cooled completely! If you try to cut it while the cable is still warm, the inner dielectric will be soft. The cutter will distort the cable and mess up the job. — *George Rulffs, AA4GR, Chelmsford, Massachusetts*



Circuit-board etching pattern for the VXO cw 30-meter exciter. The parts-placement diagram appears on page 33, this issue. Black areas represent unetched copper.



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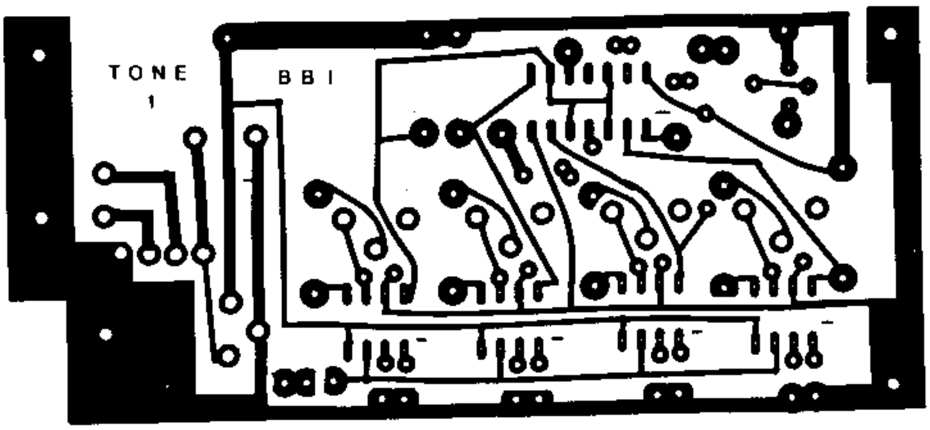

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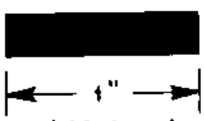

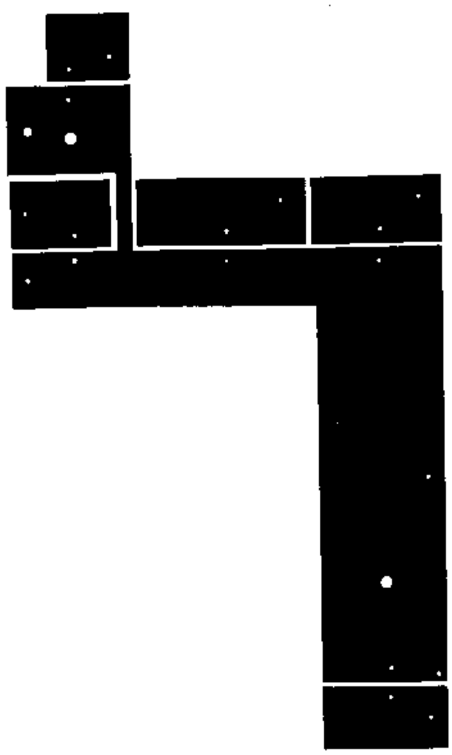

(C)

Circuit-board etching patterns for the London Tone Alert see the parts-placement diagrams of Fig. 3, on page 38 of this issue. The patterns are shown actual size. Black represents unetched copper.