PACKAGED VHF EXCITERS

SINGLE CHANNEL
28 OR 50 MEGACYCLES, 3 WATTS

FOUR CHANNELS
28 OR 50 MEGACYCLES, 3 WATTS

FOUR CHANNELS
144 MEGACYCLES, 6 WATTS

The old saying, "Good things come in small packages," was the watchword in designing these simple, compact exciters for 28-, 50- and 144-megacycle amateur transmitters. Try the circuits—and utilize construction ideas—in your next transmitter for one or more of these bands.

—Lighthouse Larry

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PACKAGED VHF EXCITERS

It's smart to build new equipment for your amateur station in small units for improved flexibility, shielding and ease of making modifications. This concept is demonstrated in packaged exciter units for transmitters operating in the 28-, 50- and 144-megacycle bands, which can provide output of about 3 watts and the 144-megacycle exciter about 6 watts of power output. This power is sufficient to drive most single Class C power amplifiers in the 100-watt power class; or, for certain amplifier tubes capable of handling several hundred watts input.

Circuit Details

The basic single channel exciter unit for the 28- and 50-megacycle bands, as shown in the main schematic diagram, Fig. 1, has three stages, but only two tubes. All stages are biased for Class C operation. The triode section of a 6SL7 triode-pentode is an oscillator for crystals in the 6- to 9-megacycle frequency range. TABLE 1 lists the choice of crystals for each band, and the frequencies to which the resonant circuits in each stage are tuned for output on the 28-, 50- and 144-megacycle bands.

There may be a few eyebrows raised over our selection of a fundamental frequency type crystal oscillator instead of an overtone circuit, especially since the recent trend has been to operate the oscillator as high in frequency as possible. However, the fundamental type oscillator, operated at low power level, assures the excellent frequency stability necessary for double sideband and other suppressed carrier transmitters—and even for CW operation without the "chirps" and "yoops" which readily identify so many VHF transmitters using overtone type oscillator circuits.

Some amateurs may prefer the convenience of a multi-channel type oscillator, rather than having to plug in a different crystal each time a switch is operated in the oscillator frequency is made. The four-channel oscillator circuits in the 50- and 144-megacycle exciters will deliver a single plate current for either crystals for a specific band, as listed in TABLE 1, with a separate tuning slug for each crystal. If all crystals for a specific band are within a fraction of a megacycle of each other in frequency—say, 5.334 to 9.000 megacycles, for a 50-megacycle exciter—only a single 28-megacycle oscillator will be needed. The plate current for each crystal is the value for a specific band, as listed in TABLE 1, with a separate tuning slug for each crystal. If all crystals for a specific band are within a fraction of the tuning plug in for the specific band of the oscillator circuit.

The pentode section of the 6SL7 amplifies either the second, third, fourth harmonic of the oscillator frequency, depending on the crystal frequency, and band upon which output is required. The third stage, a 6CL6 pentode, always operates as a frequency doubler. The RF output from the 6CL6 stage is coupled to a coaxial cable with a 3-turn link coil, L2, wound around the "cold" end of L1.

Coil L1 is tuned to 24 to 37 megacycles, and L2 to 48 to 54 megacycles, with only the tube and stray capacities across each. To adapt these tuning circuits for operation on the 28-megacycle band, simply add the additional capacitances C5 and C6 across L1 and L2, shown in dotted lines on the schematic diagram.

To obtain output on the 144-megacycle band, a fourth stage—a push-pull frequency tripler with a pair of 6BC5's—is added to the exciter. As shown in the tripler schematic diagram, Fig. 3, this stage is driven by the oscillator grid coil C1; L1 to L5 in the 6CL6 serves as a handpas coupling the 48 to 49.5-megacycle range. The plate tank circuit L5-L6 is tuned to the 49.5-megacycle band. Output from this stage is obtained from a 2-turn link coil L3, inserted at the center of L6.

The four-stage exciter can be used on both the 50- and 144-megacycle bands by winding the link coil, L3, around L6 and connecting it to a separate RF output jack. Some means of disabling the push-pull 6CL6 stage for 50-megacycle operation should be included in the external power circuitry. The tuning slips in coils L1, L2, and L3 probably will have to be readjusted when changing from 50 to 144-megacycle output.

A suggested circuit by which the heater and plate power may be switched between any two exciters is shown in the schematic diagram of Fig. 4. If desired, a third switch position on R6, and third power socket, can be added to accommodate a third exciter.

TABLE I—OPERATING FREQUENCY CHART

<table>
<thead>
<tr>
<th>OUTPUT BAND</th>
<th>CRYSTAL AND L1-C1</th>
<th>2ND STAGE L1-C2</th>
<th>3RD STAGE L1-C2</th>
<th>4TH STAGE L1-C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>28 MC.</td>
<td>7.000-7.433 MC.</td>
<td>14.0-14.850 MC. (doubler)</td>
<td>28.0-29.70 MC. (doubler)</td>
<td>None</td>
</tr>
<tr>
<td>50 MC.</td>
<td>6.25-6.75 MC.</td>
<td>25.0-31.75 MC. (doubler)</td>
<td>50.0-54.5 MC. (doubler)</td>
<td>None</td>
</tr>
<tr>
<td>50 MC.</td>
<td>8.33-9.00 MC.</td>
<td>25.0-31.75 MC.</td>
<td>50.0-54.5 MC. (doubler)</td>
<td>None</td>
</tr>
<tr>
<td>144 MC.</td>
<td>6.000-6.166 MC.</td>
<td>24.0-24.856 MC. (doubler)</td>
<td>48.0-49.333 MC. (tripler)</td>
<td>144.0-144.8 MC. (tripler)</td>
</tr>
<tr>
<td>144 MC.</td>
<td>8.000-8.322 MC.</td>
<td>24.0-24.846 MC. (tripler)</td>
<td>48.0-49.333 MC. (doubler)</td>
<td>144.0-144.8 MC. (doubler)</td>
</tr>
</tbody>
</table>

MECHANICAL DETAILS

Miniboxes were designed around the complete chassis for the VHF exciters, since they provide nearly complete control and power for the various exciters. The 4 x 5 x 3-inch size Minibox has adequate space for the three exciters and four transformers.

All components were mounted on the half of the Minibox which forms an open-end chassis, as shown in the drawing diagram, Fig. 5.

Metering of the control grid currents in the second, third and fourth stages of the exciters is accomplished by measuring the voltage drop across a portion of the grid bias resistance in each stage. Suggested values for the metering circuit resistors—R3, R6, R7 and R8—are included in the various schematic diagrams—have been tabulated in TABLE II. Select the proper resistor for the type of multimeter, or milliammeter, that will be used to tune the exciter. Suggested values are not exact for a specific full-scale current reading; they have been rounded off to the nearest value for 10 percent tolerance resistors.

The screen voltage connections to all tubes have been brought out to one terminal (through a suitable keying relay, for safety) for CW operation.

(Continued on page 2)
Fig. 2. Schematic diagram for the optional four-channel crystal oscillator circuit. Coils Ls. to Ls. are the same as Ls.

Fig. 3. Schematic diagram of the push-pull tripler circuit for the 144-megacycle band. The power metering and RF driving circuits connect to those in the basic schematic diagram Fig. 1.

Fig. 4. Suggested power connection and wiring, and metering circuits for use with two packaged exciters. Additional power connectors can be added to the circuit as required.

**TABLE II—METERING RESISTORS**

<table>
<thead>
<tr>
<th>Range</th>
<th>Resistance</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 ma</td>
<td>1,000</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>0-0.5 ma</td>
<td>62</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>0-0.25 ma</td>
<td>56</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>0-5 volts</td>
<td>6,200</td>
<td>1,000</td>
<td>24,000</td>
</tr>
<tr>
<td>0-5 volts</td>
<td>5,100</td>
<td>1,000</td>
<td>91,000</td>
</tr>
</tbody>
</table>

**COIL TABLE**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4 in. or inch diameter, 1.5 lb. inch long</td>
<td>Cambridge Thermionic Corp. type CTC-LS-40</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-8 cm, 4 cm, 6 cm, 10 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 cm, 6 cm, 10 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 cm, 10 cm, 15 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 cm, 15 cm, 20 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 cm, 20 cm, 25 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 cm, 25 cm, 30 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 cm, 40 cm, 50 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40 cm, 50 cm, 60 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 cm, 60 cm, 70 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60 cm, 70 cm, 80 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80 cm, 90 cm, 100 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 cm, 110 cm, 120 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>120 cm, 130 cm, 140 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>140 cm, 150 cm, 160 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>160 cm, 170 cm, 180 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>180 cm, 190 cm, 200 cm long</td>
<td>for screen or control grid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PARTS LIST**

C. 62 mfd NPO ceramic, or mica, 200 volts
C. 47 mfd NPO ceramic, or mica, 200 volts (See Text)
C. 39 mfd NPO ceramic, or mica, 200 volts (See Text)
C. 6.8 mfd NPO ceramic, 200 volts
C. 2.7-10.8 mfd per section, butterfly variable capacitor
J. Midget chokes type phone jack
J. Insulated phone tip jack
J. Non-insulated phone tip jack
C. Coils, see COIL TABLE
C. Meter, see TABLE II
C. Meter short resistors, see TABLE II
C. 18 cm or RF choke (Chenale 2-144)
S. Two-pole, four-position ceramic top switch (Centralab No. PA-2003 4-position switch set for four positions)
S. Top switch (three positions if three switches are used)
S. One-pole, five-position top switch

**TABLE I**

<table>
<thead>
<tr>
<th>Range &amp; Resistance</th>
<th>R1</th>
<th>R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1 ma.</td>
<td>1,000</td>
<td>2</td>
</tr>
<tr>
<td>0-0.5 ma.</td>
<td>62</td>
<td>10</td>
</tr>
<tr>
<td>0-0.25 ma.</td>
<td>56</td>
<td>10</td>
</tr>
<tr>
<td>0-5 volts</td>
<td>6,200</td>
<td>1,000</td>
</tr>
<tr>
<td>0-5 volts</td>
<td>5,100</td>
<td>1,000</td>
</tr>
</tbody>
</table>
Fig. 5. Drilling diagrams for the 4 x 5 x 3-inch miniboxes in which exciters for the 28- and 50-megacycle bands were assembled. Left—the single channel exciter; right—the four-channel exciter. Any of the following boxes may be used: Bud CU-3005; ICA 29340; Premier AMC-1005; Wyco E-923; and LMB TF-779.

Fig. 6. Top and bottom view photographs of the exciters for 28 and 50 megacycles. Left—the single channel exciter. Right—the four-channel exciter. On both models the 1/2-inch diameter socket hole for the power connector, J1, was punched 1½ inches down from the chassis deck; and 3 inches in from the oscillator end of the chassis.
A similar parts layout was followed for both the single- and four-channel exciters; the principal difference being that the tube socket locations were shifted slightly on the four-channel exciter to allow more room for the crystal sockets and oscillator plate circuit coils, $L_A$ to $L_L$. Comparison of the top and bottom view photographs of the exciters, Fig. 6, will show that the four-channel exciter appears more compact than it actually is, largely due to the use of a two-watt tap switch for $B$.

Bots were provided for the machine screws which fasten the octal sockets for the crystals in place; these are drills for a 1/32-inch diameter shaft and are tapped with 1/4-20-threaded inserts. The mounting bracket holders run parallel with the chassis. The octal sockets will accommodate crystal holders having 0.049-inch diameter pins spaced 0.486 of an inch. Four special crystal sockets may be substituted, particularly if crystal holders having 0.050-inch diameter pins will be employed, by drilling the chassis differently.

The RF output connector, $J_0$, was mounted on the chassis deck, above $L_2$, in the single channel exciter. This permitted the link coil, $L_1$, to be suspended from the lugs on $J_0$. In the four-channel exciter, $J_2$ was located on the rear of the chassis. A single length of insulated hookup wire was wound around $L_2$ to form $L_3$, and the excess wire was twisted and run back to $J_2$. The power connector, $J_1$, also mounts on the rear of the chassis in the location shown in the bottom view. A larger Minibak, 2.7 x 3 inches in size, provides the additional space required for the push-pull 6CL6 tripler stage in the 144-megacycle exciter model. The parts layout for the first three stages, as shown in the drilling diagram for the four-stage exciter, Fig. 7, is essentially similar to the four-channel, three-stage exciter previously described. The bottom view photograph shows that somewhat more space is available for the oscillator plate coils on the 5-inch-wide chassis. In this model, a single wattle tap switch was used for $G$.

Brackets for the 6CL6 tubes and other components in the tripler stage have been provided to permit very short connections. The coils in the bandpass coupling, $L_A$, is 0.162-inch diameter, and is located in a bracket marked "A," instead of being fastened to the front wall of the chassis. Another angle bracket, marked "B," supports the plate tuning capacitor, $C$. The dimensions and drilling details for both brackets are shown in Fig. 8.

Shells which extend these three tuning adjustments out through the front panel were made from 1/4-inch diameter brass rod. Drill and tap a hole for a 6-32 machine screw in one end of the 1/16-inch long shafts for $L_A$ and $L_L$, and use a slot for a 200-microampere fuse in the other end. After the coils have been mounted, first assemble a 6-32 hex nut on the slug screws, then run the extension shaft onto this screw about six turns and tighten the lock nut against the end of the shaft. The shaft may be run through a 1/4-inch diameter hole in the chassis, or through a panel bearing, as illustrated.

Since $C$ has a 3/16-inch diameter shaft, a special extension shaft was made by drilling a 1/8-inch diameter hole through a 1/4-inch length of brass rod 1/4 of an inch in diameter. Then, about one half of the $C$ slug screw was enlarged to 1/4 of an inch in diameter, and a 1/16-inch length of 1/8-inch diameter brass rod is soldered to the enlarged portion. The hole is drilled and tapped for a set screw which is shown in the bottom view. The extension shaft will be mounted in a drilled and tapped 1/4-inch diameter hole in the chassis, or panel bearing, before $C$, and its mounting bracket are fastened in place.

The tie points which support the resistors and other small parts are located in the proper places in one of the drilling diagrams for each exciter. Most resistors are soldered directly between lugs on components to which they are connected. All disc ceramic by-pass capacitors are mounted in parallel between resistors for best possible leads; those which bypass the screen grid of tubes in the second, third and fourth stages should be connected between the screen grid and cathode lugs on the tube sockets. All grid and plate leads are No. 16 tinned copper wire, also as short as possible. Power leads are insulated No. 30 stranded hookup wire, run close to the chassis wherever possible to reduce RF pickup. Most other constructional details should be apparent after studying the illustrations.

**ÖPRAH**

To make the turn-up procedure more meaningful, we'll assume that a four-channel, 30-megacycle exciter is being adjusted for broadside operation between 20 and 51 megacycles (crystal frequencies between 8.394 and 8.509 megacycles). Two crystals, one each at $A$ and $B$, would be substituted so that the output would be fed into a 7-meter bandpass coupler. The exciter was also constructed with a 41-megecycle output filter, $J_2$, and a 43.5-megacycle output filter, $J_3$, for the tube and plate tests.
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(a 8.450-megacycle crystal);

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The grid

frequency

of

The tripler plate circuit tuning capacitor,

may be tuned to 144.5 megacycles if most operating will take place in the 144- to 145-megacycle range. However, if the entire power output of the exciter is required to drive a succeeding power amplifier, C, probably will have to be retuned each time a shift in operating frequency greater than 200 kilocycles is made.

All of the popular twin pentode power tubes designed for operation in the VHF spectrum—815, 829B, 5894—or a pair of 814's—in push-pull circuits, make an excellent power amplifier to follow these exciters. Circuits and construction ideas for amplifiers using these tubes may be found in the list published below.

829B and 5894:

"1. 144-megacycle Double Beam-tetrode Power Amplifiers." QST, March, 1948, page 38; or ARRL Handbooks, VHF Transmitters chapter, 1948 to 1952 editions.


"5: A 60-watt Transmitter for 50, 28 and 144 Megacycles." ARRL Handbooks, 1948 to 1951 editions.

6146:


Fig. 9. Bottom view photograph of the 144-megacycle exciter. The crystal switch, in this model, L, was assembled from a Centralab 5000 miniature rotary switch index assembly, and a FAC 0.0625-μA position-critical top switch section. One 0.1-inch and one 0.05-inch long spacer was assembled on each threaded red between the switch washer and the index plate. The output link set, L, is wound with 3-inch lead spaced about 1/2 inch for the connections to J, bottom

extension shafts on L, L, and G, are given in the text under MECHANICAL DETAILS. The power con-

section, L, was wound in the same position as described for the three-stages exciters, Fig. 8.
Sweeping the Spectrum

Meet the designer—K2DBS, William F. Kall, a rate engineer with G.E.'s Communication Products Department, has pointed the way toward improving the frequency stability of VHF transmitters with his Packaged VHF Exciters, described elsewhere in this issue of G.E. Ham News. The oscillator and frequency multiplier circuits, similar to those found in G.E.'s Fine Progress Line of two-way mobile radio equipment, meet the stringent frequency stability and driving power requirements of Bill's high-level double sideband balanced modulators for the VHF bands.

Two other letters, W2QGW and W8QGT, have been held by K2DBS since his amateur radio career started in 1931. Bill now resides in North Syracuse, New York, near G.E.'s Electronics Park. As you may have surmised, Bill is one of those growing multitude of hams whose main interest is the furtherance of communications on the VHF amateur bands.

The flood of replies to our Reader Survey (See G.E. Ham News, March-April, 1958, Vol. 15, No. 11, page 7) is just being tabulated, but a quick look at the replies shows just who the readers are. A good number of them want more information on single sideband, double sideband and simple, but efficient, equipment for the VHF bands.

There also have been many requests for information on simple test equipment for the ham shack, plus instructions for calibrating it. Many of you want information on making simple tests and measurements on transmitters, receivers and antennas.

I certainly appreciate the interest of those persons who have returned the survey coupon. If you haven't seen that issue, pick up a copy from your nearest G.E. tube distributor; or, send a postal card to me, requesting it. Of course, it isn't necessary to use the survey coupon if you don't wish to cut it out of that issue; just write your answers on a postal card and send it to the following address: Lighthouse Larry, General Electric Company, Electronic Components Division, Building 201-3, Schenectady, N. Y., U.S.A.

Here's good news for all radio club television interference (TVI) committees (or for anyone with TVI problems) who never did gather a copy of the book Television Interference originally published by Philip J. Martin, A.M. A., 1957. A fifth revision of this book is now available, your $1.00 will buy a copy. The book, copyrighted in 1957, has been expanded to include an additional chapter on television interference. The Fifth Edition includes a reprint of the American Radio Relay League's New Ham Handbook, a bibliography of other books and articles on TVI and a section on FCC rules concerning TVI. (See Table 2.)

While we're speaking of W2QGW, many of you will recall that he received a special citation plaque from the judges of G.E.'s annual Edison Radio Amateur Award program for his outstanding research and contributions to the solution of TVI problems, both in the amateur radio and industrial fields.

My Log Form QRL card has just blossomed out in a new three-color combination! No—we didn't call it in a color stylist to create it—the colors are the same as those on the latest G.E. tube car—gray, green and black.

There are now millions of these cards in circulation. You may see them in other colors—beige, blue or maroon—but we firmly believe that the new three-color card is the best. The new card—sample card—Form 73B—just write, "Sample QRL" address—we'll send an address on a postal card—or use of your present QRL card—and we'll send it to you.

The cards are furnished without imprinted, packaged in quantities of 120, ready to mail, postpaid, to those persons who can't get a check or money order for $1.00. Of course, if you need more cards (500, 750, 1000, or other multiples of 250), we'll ship a real big package of them to you at the same rate. And be sure to include your complete mailing address—we want to make sure that your cards arrive without delay.

We've received a great number of requests for an updated edition of the G.E. Ham News DX Log since it was last revised (See G.E. Ham News, January-February, 1955, Vol. 11, No. 1). Altogether, four editions of this issue have been published. A fifth revision is now in the works, and in it, the spacing between lines will be expanded to allow more room for change. Also, a coupon ordering card will be placed on the correct continents; a special listing of outstanding better prefixes and countries no longer on the official list will be added; and, finally, the whole issue will be printed in color. We're in it for greater ease in writing.

You, the many users of our DX Log, are best qualified to know what improvements, other than the above, should be made in the upcoming edition. We'll be happy to include as many features as possible.

And if you're anxious to know when this new DX Log will be available, your local G.E. tube distributor should have them early in August.
Looking for still other VHF exciter construction ideas? Here's how the designer of the packaged exciters, K2DBS, has combined two exciters on a single flat metal plate for his own VHF station. The view above (left) shows how the exciters and a Allen-Bradley high frequency power amplifier unit, share an 8½ x 19-inch relay rack panel.

Both exciters have single channel oscillator circuits: the three-stage exciter for 28 and 50 megacycles occupies the lower portion of the plate; and the 144-megacycle four-stage exciter runs up the right side, and across the top. A 6360 twin pentode tube was used in the 144-megacycle tripler, instead of the two 6CL6 tubes shown in Fig. 3.

The under-chassis view (right) shows the constructional details and principal differences between this exciter and the packaged exciters built in Miniboxes (Figs. 8 and 9). A barrier terminal strip for the power and 300-ohm twinlead RF output connections; rotary tap switch to transfer power from one exciter to the other (S1, in Fig. 4); and insulated tip jack (13, J, and J1, instead of J, in Fig. 1) for plugging in a test meter to measure the grid current in each stage.

If you want further details on this model, send a postal card to me, and I'll mail a full-size chassis drilling diagram, and schematic showing the exact circuit used, to you.

—Lighthouse Barry