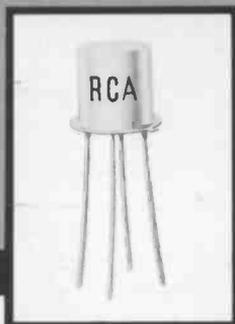




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A 144-Mc Antenna-Matching Preamplifier

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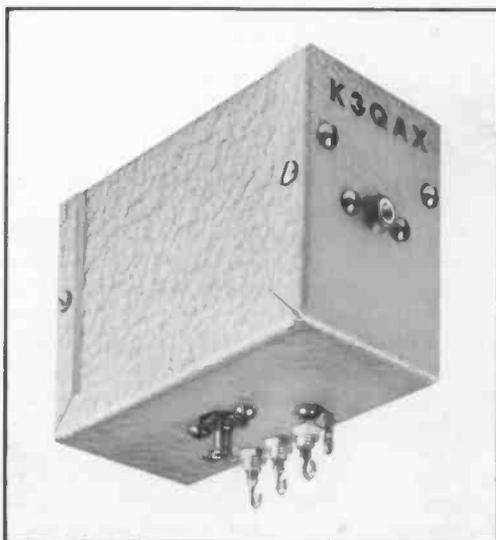
Looking for a reliable, economical way to:

- Amplify signals before they're lost in the noise of your antenna system?
- Overcome losses inherent in long feed lines?
- Provide a better match between antenna and feed line?

Here's a new device for radio amateurs which integrates an antenna-matching circuit with a VHF transistor amplifier. The device combines an antenna-matching arrangement, a relay to switch the antenna between receiver and transmitter, and a 2N2708 VHF preamplifier stage. Simplicity in construction and operation insures easy duplication of the unit.

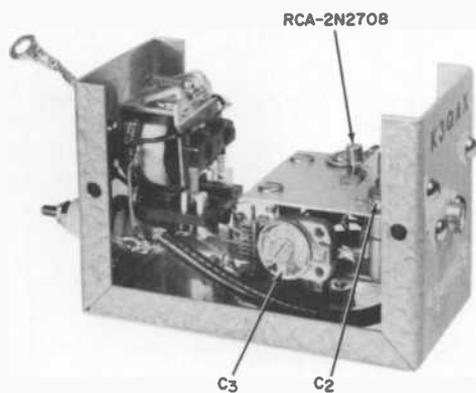
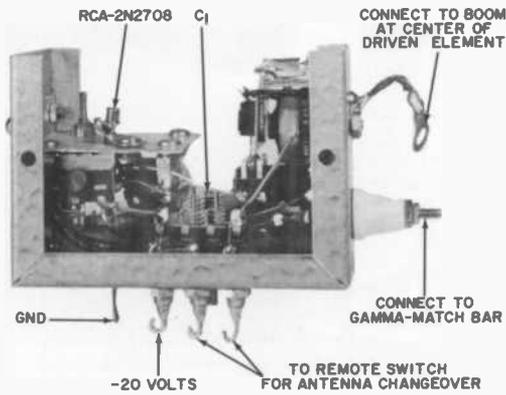
Background

Antenna mismatch and feed-line resistance losses, which are only of academic interest on the amateur high-frequency bands, become very real problems in high-power transmission above 50 megacycles. At these frequencies, even modest antenna-mismatch losses may be unacceptable because of the difficulty encountered in generating the required power as the frequency increases. At high power levels, feed-line resistance losses may be sufficient to cause severe damage to long runs of expensive coaxial cable. While it is true that only the worst conditions impair incoming signals at 50 megacycles, the operator who employs higher frequencies may find weak but otherwise readable signals irretrievably lost in noise. At 144 Mc, efficient transmitter operation at appreciable power levels—as well as the ability of the receiver to distinguish signals from noise—are limited by feed-line resistance (length) and antenna mismatch.



144-Mc Antenna-Matching Preamplifier built by K3QAX/W2QEX employs the RCA-2N2708, a silicon n-p-n double-diffused epitaxial-type planar transistor intended for amplifier, mixer, and oscillator applications up to 500 Mc.

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Side views of preamplifier chassis showing locations of unit's principal components.

To most amateurs operating on the VHF bands, antenna matching is no problem. The difficulty arises in coping with the feed-line resistance after the match has been achieved. In the past, there were two alternatives:

(1) A compromise between stronger signals at the antenna with larger feed-line losses (i.e., higher antenna, longer feed lines) and weaker initial signals with lower losses;

(2) Mounting the preamplifier near the antenna to overcome feed-line loss of incoming signals.

The latter method was seldom used, however, because of the problems involved in mounting a conventional tube preamplifier on the antenna. In addition, it was difficult to provide power for switching the antenna between transmitter and receiver, and to supply filament and B+ voltage to the tube and protect it against environmental stresses.

New Solution

The RCA-2N2708 VHF silicon transistor makes available to amateurs the first low-noise, low-cost component sufficiently rugged and reliable for antenna-mounted VHF service.

The antenna-matching preamplifier (see Figure 1) uses the 2N2708 with standard com-

ponents and an inexpensive relay to provide a minimum gain of 8 db in receiving. The "package" also includes an integral capacitor for use in a gamma-match arrangement that will properly match an antenna for both transmitting and receiving.

It is important that the device be confined to use with transmitters having a maximum input power of 100 watts. Using higher-cost materials (including coaxial relays), however, there is no reason why the principles described could not be applied to similar devices capable of handling higher input powers and higher frequencies. The RCA-2N2708 transistor may be employed at frequencies up to 500 megacycles. RCA's 2N2857, on the other hand, can be used at frequencies up to 1,000 megacycles.

The Amplifier

The 2N2708 amplifier is constructed on an aluminum strip which has a lip for mounting to the wall of the Mini-Box. The aluminum strip measures 1½ inches square with a ½-inch lip, while the Mini-Box measures 4 inches by 2¼ inches by 2¼ inches. In this instance, conventional-size components were used because of their ready availability; however, equivalent miniature items may easily be substituted. In any event, the author followed the customary VHF construction practices of laying out components so they might be connected with the shortest leads possible. No "wire" other than component leads was used in the amplifier construction.

In building the amplifier, the shield lead from the 2N2708 transistor is soldered directly to a ground lug on top of the amplifier chassis. It is recommended that the lead be clamped with a pair of long-nose pliers between the transistor and the ground lug to help dissipate heat away from the transistor. Connections to other leads are made by inserting the 2N2708 into a conventional three-terminal transistor socket. (The builder may find it advantageous to use a Grayhill-type 22-11 four-terminal socket for mounting the 2N2708. The socket terminal mating with the shield lead may then be grounded.)

During reception, the input signal is applied directly to the unneutralized RF amplifier from the gamma-match bar (through reactance-cancelling capacitor, C₁ shown in Figure 1 schematic). During transmission, the relay switches capacitor C₁ from the amplifier to the coaxial feed line and disconnects the output of the amplifier from the feed line. In this manner, the amplifier is isolated from both the antenna and feed line.

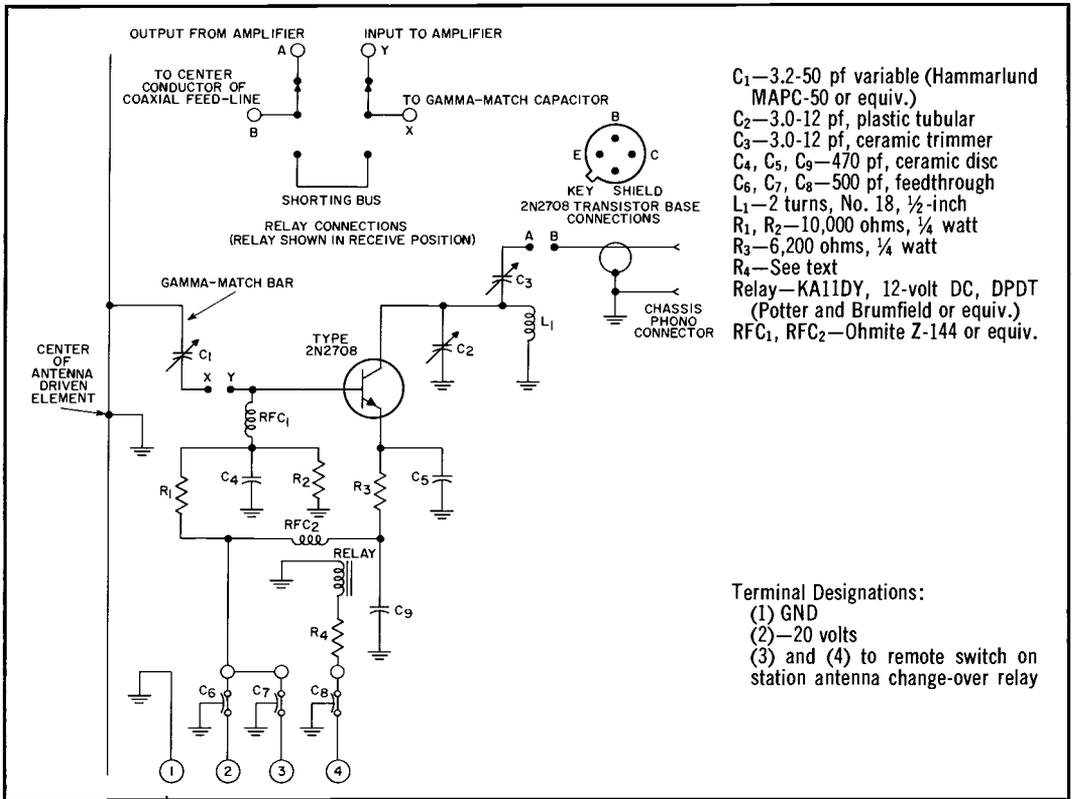


Figure 1: Schematic diagram and parts list of K3QAX/W2QEX's antenna-matching preamplifier.

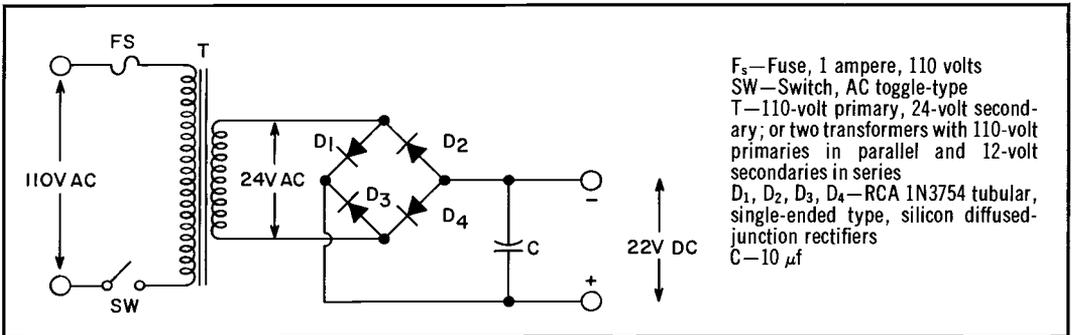


Figure 2: Suitable single-phase full-wave bridge power supply for antenna-matching preamplifier.

General Construction and Set-Up

The unit may be mounted on the antenna boom in any convenient manner. Perhaps the easiest method is by merely fastening a small U-bolt to the top of the Mini-Box and connecting a braided ground strap between a lug at the rear of the Mini-Box and a point on the antenna boom directly in line with the gamma-match bar. As the ground strap might be a source of additional inductive reactance that must be cancelled by the capacitor, C₁, it

should be kept as short as possible.

Capacitor C₁ is connected to the gamma-match bar through a ceramic feedthrough mounted on back of the Mini-Box. It is insulated against the metal box by a thin sheet of Lucite or similar plastic material which is drilled and mounted so that the capacitor shaft does not touch the sides of the oversize shaft hole in the metal.

The RCA-2N2708 transistor provides good performance and usable gain with applied power from 18 to 20 volts direct current.

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Within this range, voltage is critical only with respect to reliable operation of the receive-transmit relay. The value of R_4 should be chosen so that the voltage at the relay terminals is 12 volts. When the system is ready for operation and the length of cable has been determined, the voltage available at the point of entry into the amplifier case should be measured. The value of R_4 should be 80 ohms for a voltage of 20 volts, or 60 ohms for a voltage of 18 volts. (If the builder elects to use a 24-volt direct-current relay, R_4 may be eliminated.)

A suitable DC power source for the unit is shown in Figure 2. Alternatively, the required power may be supplied by batteries. A current of approximately 125 milliamperes is required over a DC voltage range of 18 to 20 volts.

Operation

Initial tune-up of the antenna-matching preamplifier involves adjustment of the internal reactance-cancelling capacitor, C_1 , and the gamma-match bar, and further requires the use of a VSWR bridge designed to remain in the feed line at all times. When this VSWR bridge has been adjusted for full-scale readings in the "Forward" position, the meter is switched to read "Reflected" power and the length of the gamma-match bar is adjusted for a minimum meter reading. The VSWR at this point might be as high as 2.5 or 3 to 1. C_1 is then adjusted for a ratio of 1 to 1 at the desired

frequency, which is a perfect match between feed line and antenna. Readjustment of the gamma-match bar and C_1 may be necessary before a perfect match is achieved. The design of the beam antenna, the number of elements, and the spacing between them determine the impedance to be matched and the positions of the gamma-match bar and the capacitor, C_1 .

Prior to tuning the transistor amplifier, the builder should employ a grid-dip meter or some other suitable device to assure that the C_2 - L_1 combination will tune to the 144-to-148-megacycle band. With the antenna-matching preamplifier mounted to your beam, and with the station receiver tuned to an appropriate test signal, C_3 and C_2 are then tuned for the desired amount of coupling and proper output frequency, respectively. Interaction between C_3 and C_2 makes it necessary to locate—by experimentation—that point at which C_3 produces the desired coupling and C_2 tunes the amplifier output to the desired frequency. Both of these objectives, it should be realized, produce increased signal in the receiver from the test-signal source. As a general rule, C_3 should be near maximum and C_2 near minimum capacitance.

Relatively easy to construct and operate, the 144-Mc Antenna-Matching Preamplifier represents an efficient and inexpensive method for overcoming the effect of long feed lines and properly matching an operator's feed line to his antenna.