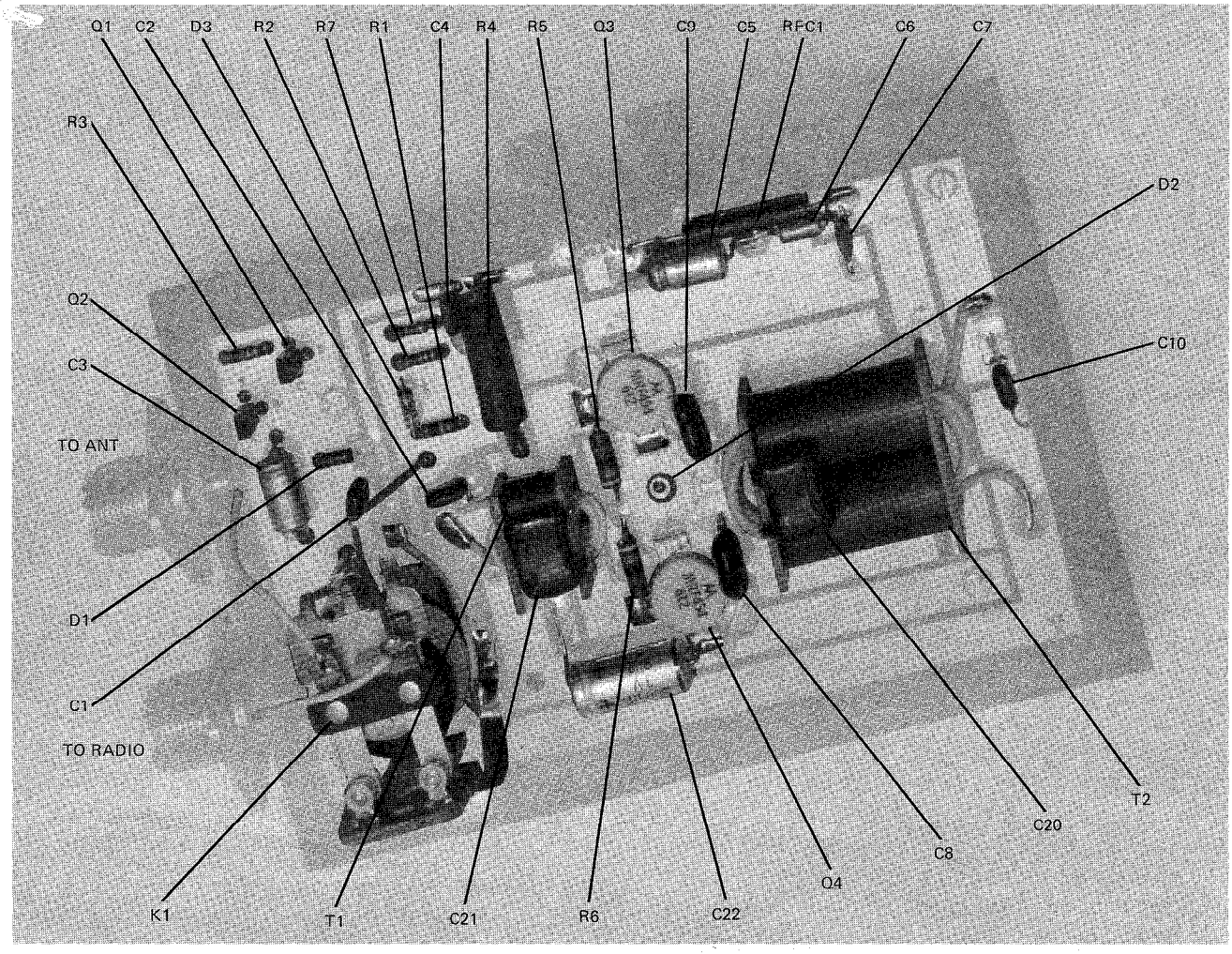
COMMUNICATIONS

Engineering Bulletin

By: Tom Bishop
RF Circuits Engineering

140W (PEP) Amateur Radio Linear Amplifier 2-30MHz



The popularity of 2-30 MHz, SSB, Solid State, linear amplifiers is increasing in the amateur market. This EB describes an inexpensive, easy to construct amplifier and some pertinent performance information. The amplifier uses two MRF454 devices. These transistors are specified at 80 Watts power output with 5 Watts of input drive, 30 MHz, and 12.5 Vdc. The MRF454 is used because it is a readily available device and has the high saturation power and ruggedness desired for this application. This device is not characterized for SSB. However, IMD specs for the amplifier are shown in Figures 2 and 3.

THE AMPLIFIER

The performance of the amplifier can be seen in figures 1, 2, 3, 5, 6, 7 and 8. The quiescent current is 500 mA on each device. This amount of bias was needed to prevent "cross over" at the higher output powers during SSB operation. The amplifier operates across the 2-30 MHz band with relatively flat gain response and reaches gain saturation at approximately 210 Watts of output power. Figure 5 depicts the amplitude modulated waveform with respect to a 100-Watt carrier. Figure 6 depicts the increased amplitude modulation at 50-Watt carrier. In both cases the peak output power is equal to approximately 210 Watts due to the saturation of the MRF454. The 50-Watt carrier is thus recommended in any amplitude modulated applications.

The bias diode D2 has been mounted in the heatsink for temperature tracking. The cathode is pressed into the heatsink and the anode extends through the circuit board. (See figure 9.) Both input and output transformers are 4:1 turns ratio (16:1 impedance ratio) to achieve low input SWR across the specified band and a high saturation capability. T1* is made from FairRite Products, ferrite beads, material #77, .375" O.D. x .187/.200" I.D. x .44L". T2* is made from Stackpole Co. ferrite sleeves #57-0503-7D.

When using this design, it is important to interconnect the ground plane on the bottom of the board to the top; especially at the emitters of the MRF454s. Eyelets were used in this design, which are easier to apply, but #18 AWG wire can be used. On the photomask, (see figure 10) ":" signifies where the ground plane has been interconnected. The letter "O" designates where the 4-40 screws are installed to fasten the board to the heatsink. 6-32 nuts are used as spacers on the 4-40 screws between the board and the heatsink to keep the board from touching the heatsink.

THE DESIGN

This amplifier was designed for simplicity. The design goal was to allow repeatability of assembly and reduce the number of components used. The amplifier will accept Single Side Band or Amplitude Modulation without external switching. A carrier operated relay circuit is on the same layout to make this an easy amplifier to add on to any suitable radio with an RF output of 1.0-5.0 Watts. All components used are readily available at most distributors and are relatively inexpensive.

NOTE: Similarly assembled transformers can be purchased from:

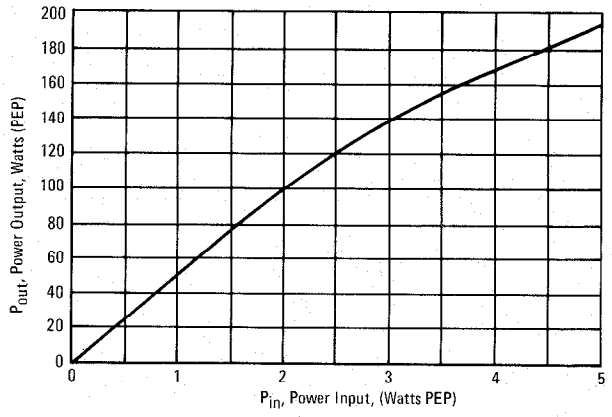


FIGURE 1–P_{out} vs. P_{in}, 30 MHz, 13.6 Vdc

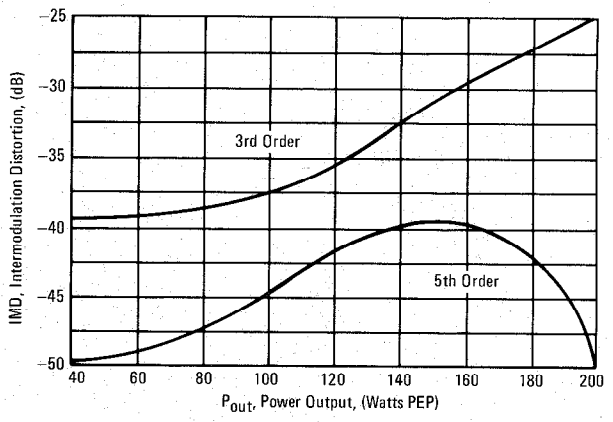


FIGURE 2–Intermodulation Distortion Versus P_{out}, 30 MHz, 13.6 Vdc

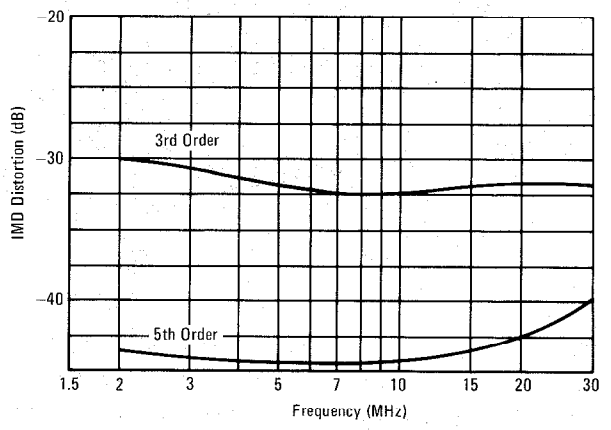
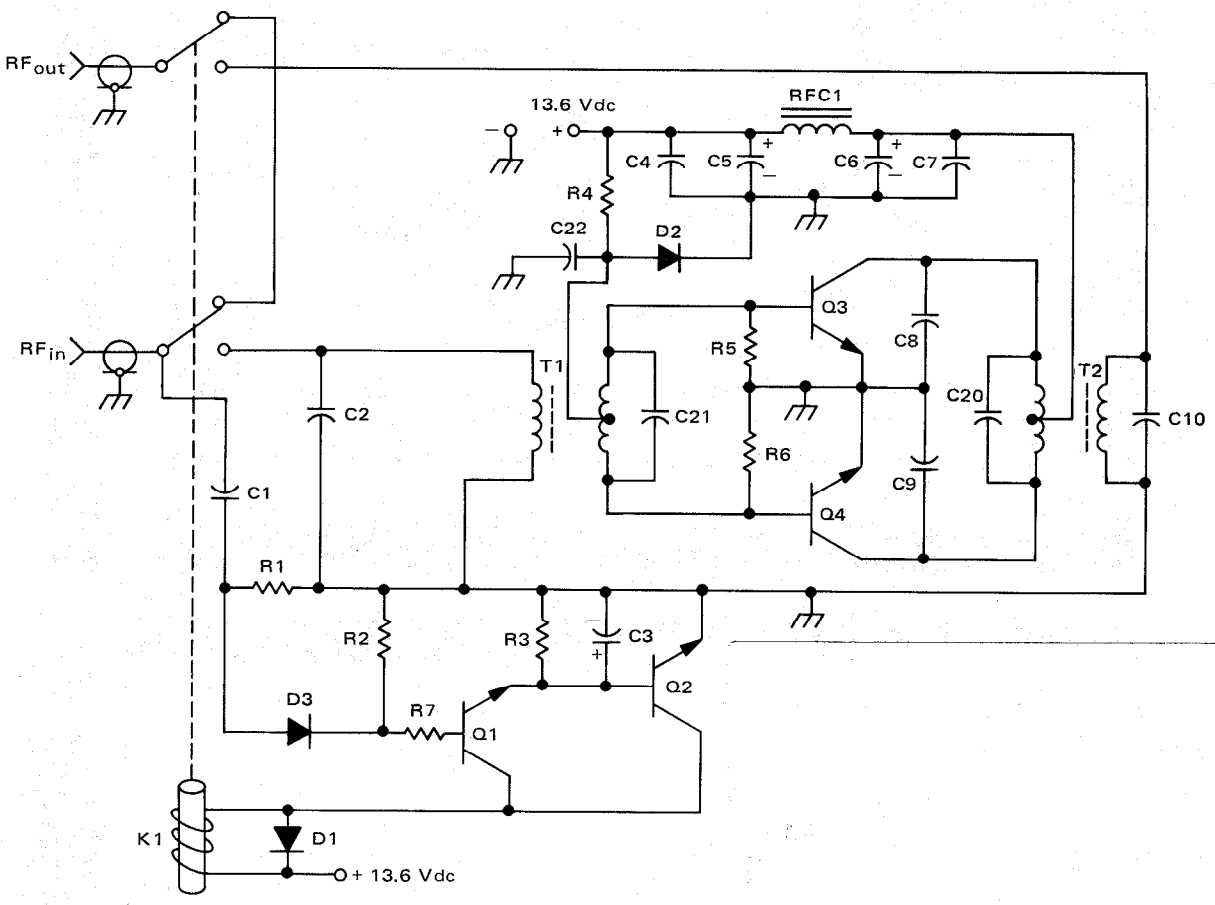


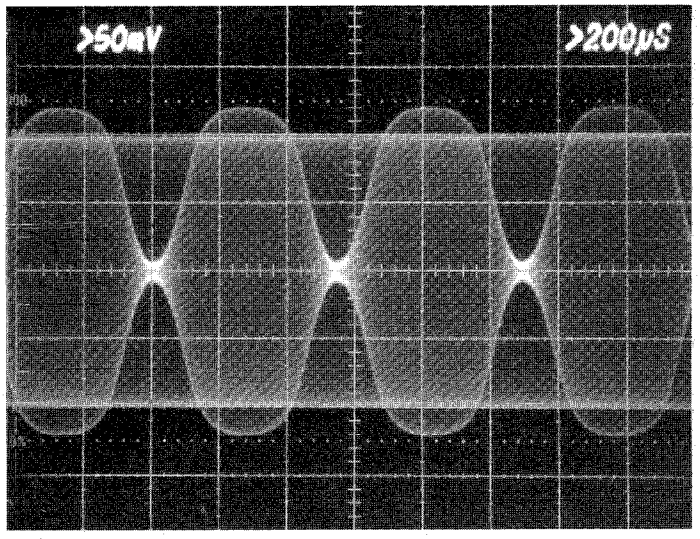
FIGURE 3–IMD vs. Frequency, P_{out} = 140 Watt PEP, 13.6 Vdc

*Ref: Application Notes
AN749 BroadBand Transformers and Power Combining Techniques for RF – H. Granberg
AN762 Linear Amplifiers for Mobile Operation – H. Granberg



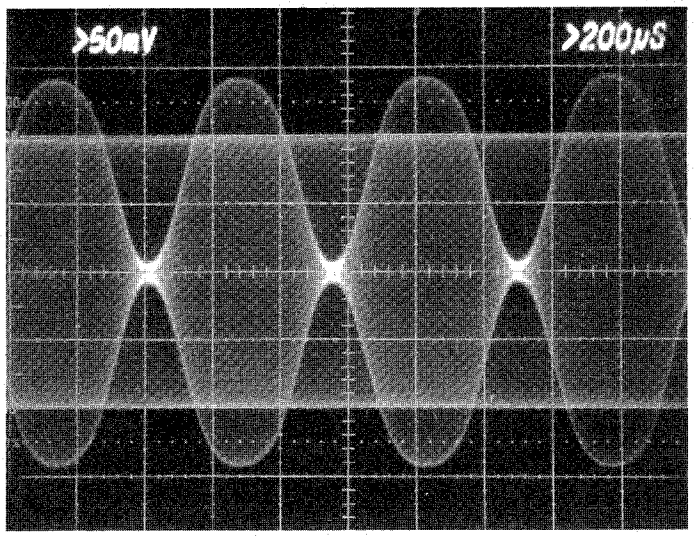
C1 = 33 pF Dipped Mica
C2 = 18 pF Dipped Mica
C3 = 10 μF 35 Vdc for AM operation, 100 μF 35 Vdc for SSB operation.
C4 = .1 μF Erie
C5 = 10 μF 35 Vdc Electrolytic
C6 = 1 μF Tantalum
C7 = .001 μF Erie Disc
C8, 9 = 330 pF Dipped Mica
R1 = 100 kΩ 1/4 W Resistor
R2, 3 = 10 kΩ 1/4 W Resistor
R4 = 33 Ω 5 W Wire Wound Resistor
R5, 6 = 10 Ω 1/2 W Resistor
R7 = 100 Ω 1/4 W Resistor
RFC1 = 9 Ferroxcube Beads on #18 AWG Wire
D1 = 1N4001
D2 = 1N4997
D3 = 1N914
Q1, Q2 = 2N4401
Q3, 4 = MRF454
T1, T2 = 16:1 Transformers
C20 = 910 pF Dipped Mica
C21 = 1100 pF Dipped Mica
C10 = 24 pF Dipped Mica
C22 = 500 μF 3 Vdc Electrolytic
K1 = Potter & Brumfield KT11A 12 Vdc Relay or Equivalent

FIGURE 4–Schematic Diagram



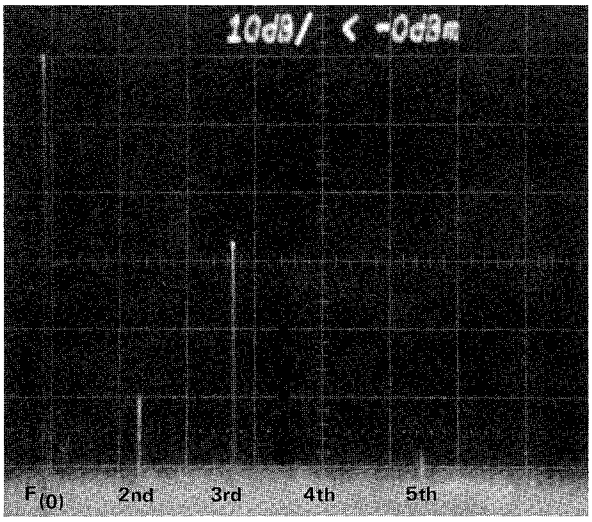
Amplitude Modulated Waveform with Superimposed Carrier. Carrier Conditions: f = 30 MHz; P_{in} = 2.2 Watts; P_{out} = 100 Watts (carrier); V_{CC} = 13.6 Vdc

FIGURE 5



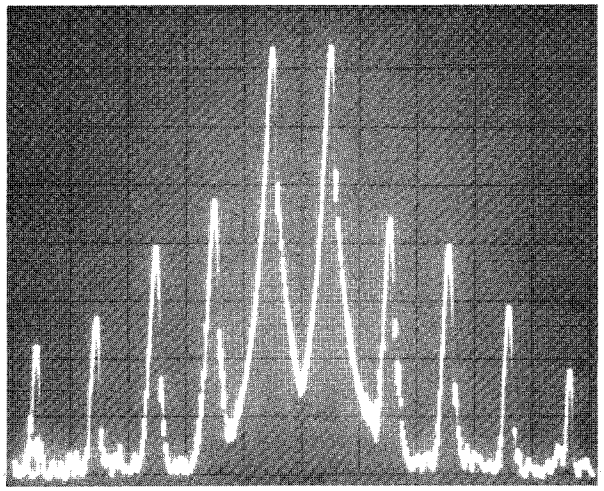
Amplitude Modulated Waveform with Superimposed Carrier. Carrier Conditions: f = 30 MHz; P_{in} = 1.3 Watt; P_{out} = 50 Watts; V_{CC} = 13.6 Vdc

FIGURE 6



Frequency Spectrum, 30 MHz ($F_{(0)}$, 2nd, 3rd, and 5th harmonics are visible). Vertical resolution: 10 dB/div. Horizontal 20MHz/div.

FIGURE 7



INTERMODULATION DISTORTION, 30, 30.001 MHz (3rd, 5th, 7th, 9th) order distortion products are visible. Vertical resolution: 10 dB/div. Horizontal: 1KHz/div.

FIGURE 8

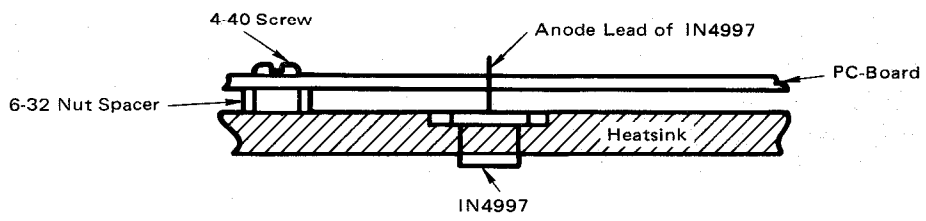
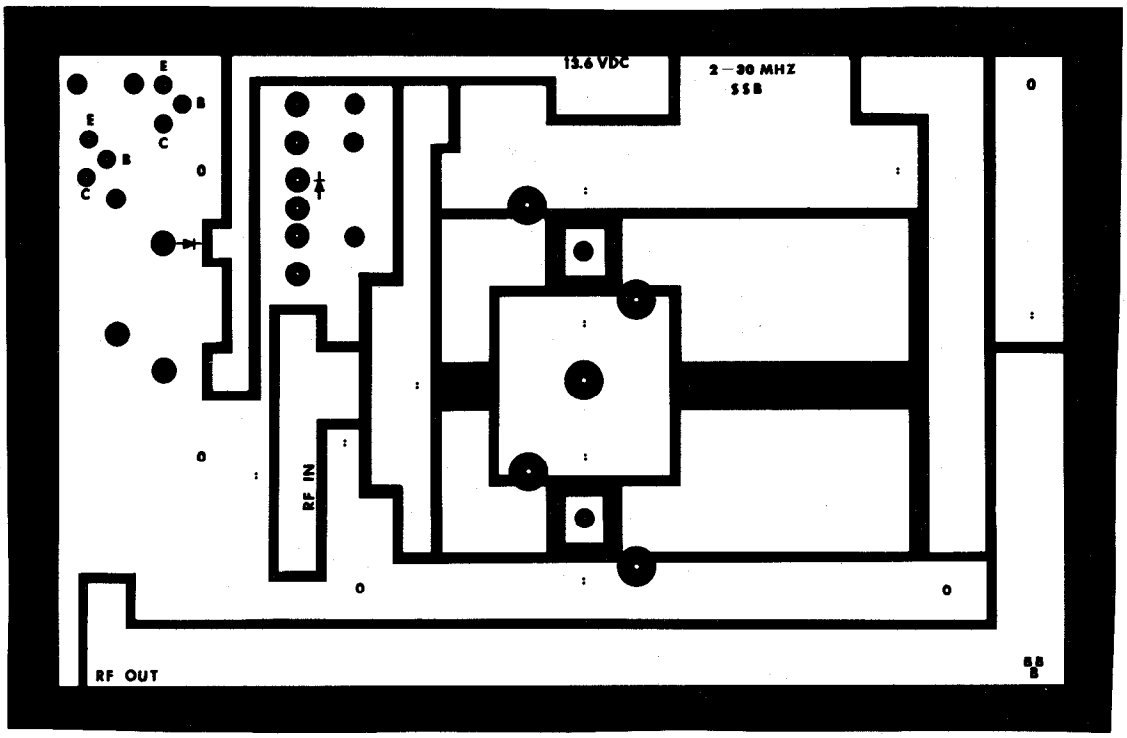


FIGURE 9 – Mounting Detail of IN4997 and 6-32 Nut (Spacer)



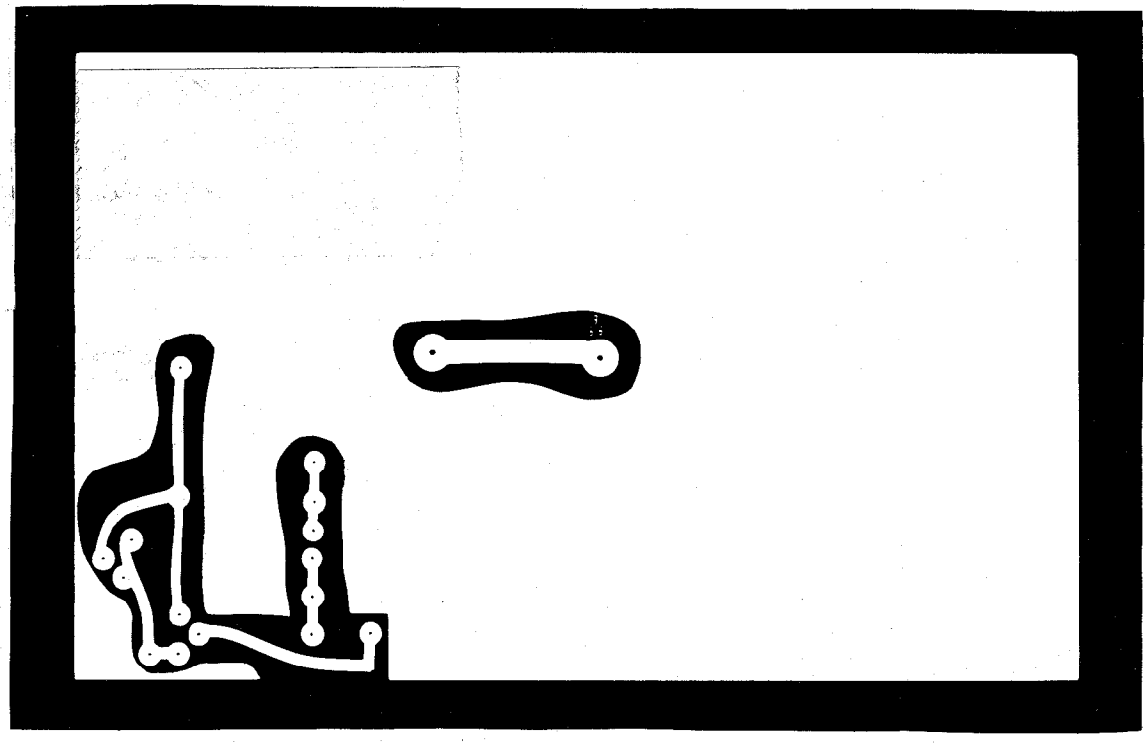


FIGURE 10–1:1 Photomaster (Positive)

Note: The use of this amplifier is illegal for Class D Citizen Band service.

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