140 W (PEP) AMATEUR RADIO LINEAR AMPLIFIER
2 – 30 MHz

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 #57-3238-7D.

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.

![Figure 1. P_out vs. P_in, 30 MHz, 13.6 Vdc](image1)

![Figure 2. Intermodulation Distortion Versus P_out, 30 MHz, 13.6 Vdc](image2)

![Figure 3. IMD vs. Frequency, P_out = 140 Watt PEP, 13.6 Vdc](image3)

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

NOTE: Parts and Kits for this amplifier are available from:

Communication Concepts, Inc. (CCI)
508 Millstone Drive
Beavercreek, Ohio 45434-5840
(513) 426-8600
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 20 MHz/div.

**Figure 7.**

Intermodulation Distortion, 30, 30.001 mhZ (3rd, 5th, 7th, 9th) order distortion products are visible. Vertical resolution: 10dB/div. Horizontal: 1 kHz/div.

**Figure 8.**

**Figure 9.** Mounting Detail of 1N4997 and 6–32 Nut (Spacer)
Figure 10. Photomaster (Positive)

Note: The use of this amplifier is illegal for Class D Citizen Band service.
Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. “Typical” parameters can and do vary in different applications. All operating parameters, including “Typicals” must be validated for each customer application by customer’s technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and A are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

Literature Distribution Centers:
USA: Motorola Literature Distribution; P.O. Box 20912; Phoenix, Arizona 85036.
EUROPE: Motorola Ltd.; European Literature Centre; 88 Tanners Drive, Blakelands, Milton Keynes, MK14 5BP, England.
JAPAN: Nippon Motorola Ltd.; 4-32-1, Nishi-Gotanda, Shinagawa-ku, Tokyo 141, Japan.
ASIA PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Center, No. 2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong.