COMMUNICATIONS

Engineering Bulletin

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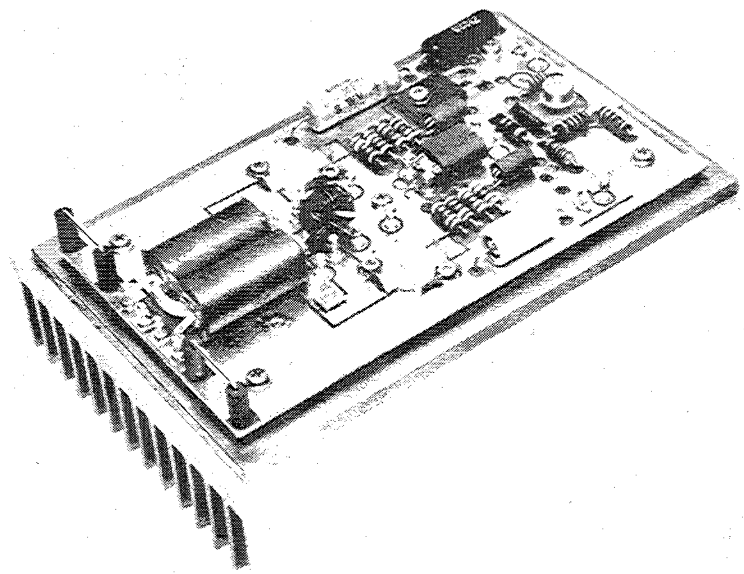
Get 300 Watts PEP Linear Across 2 To 30 MHz From This Push-Pull Amplifier

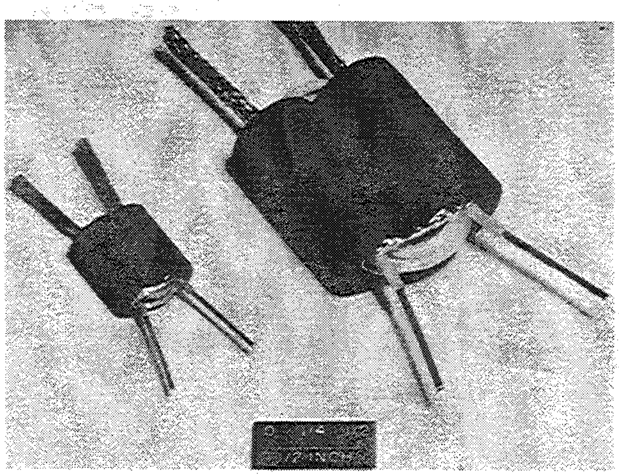


(The heat sink shown with amplifier is sufficient only for short test periods under forced air cooling.)

This bulletin supplies sufficient information to build a push-pull linear amplifier for 300 watts of PEP or CW output power across the 2- to 30-MHz band. One of Motorola's new high-power transistors developed for single-sideband, MRF422, is used in this application.

Like all transistors in its family of devices, MRF422 combines single-chip construction that is advancing the state-of-the-art, and improved packaging to accommodate the low collector efficiencies encountered in class B operation. Rated maximum output power is 150 watts CW or PEP with intermodulation distortion spec'd at −30 dB maximum, −33 dB typical. Although not recommended, a saturated power level of 240- to 250-W is achievable. Maximum allowable dissipation is 300 W at 25°C.

Because of its excellent load and line voltage regulating capabilities, an integrated circuit bias regulator is used in the amplifier. The MPC1000, originally described in this bulletin, consisted of a MC1723 chip and a built-in pass transistor. The manufacture of this device has been discontinued however, and the board lay-out was modified to incorporate the above two in separate packages. The load regulation typically measures less than 2% at current levels up to 0.5 A, which assumes an h_{FE} of 40 for the RF power devices. The board surface provides a sufficient heat sink for the 2N5990 pass transistor, but a separate heat dissipator, such as Thermalloy 6107 can be added if necessary. With the component values shown, the bias is adjustable from 0.4 to 0.8 volts.



Transformer Construction

Gain flatness over the band is achieved using base input networks R_1C_2 and R_2C_3 and negative feedback through R_3 and R_4. The networks represent a series reactance of 0.69 ohms at 30 MHz rising to 1.48 ohms at 2 MHz. A single-turn winding in the collector choke provides a low-impedance negative feedback source, thus R_3 and R_4 determine the amount. The reactance of C_4 reduces feedback at high frequencies with the result that feedback increases an average of 4 dB per octave at decreasing frequency.

For continuous operation at full power CW, it is recommended that heat sink compound, such as Dow Corning #340, be applied between the board surface and R_3 and R_4, and if possible have air circulating over the top of the circuit board as well.

The effective base-to-base impedance, increased by the RC networks is about 5 ohms at midband. As a result of this and the 9:1 impedance ratio in the input transformer T1, the input VSWR is limited to 1.9:1 or less across the band. Transformer T2, in addition to providing a source for the feedback and carrying the dc collector current, acts as the rf center tap of the output transformer. To construct T2, wind 5 turns of 2 twisted pairs of AWG No. 22 enameled wire on a Stackpole 57-9322 toroid (Indiana General F627-8Q1).

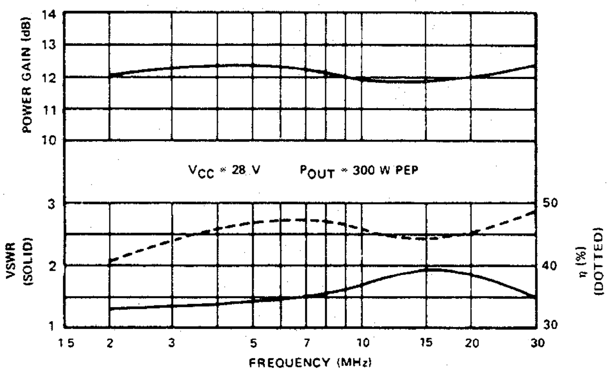
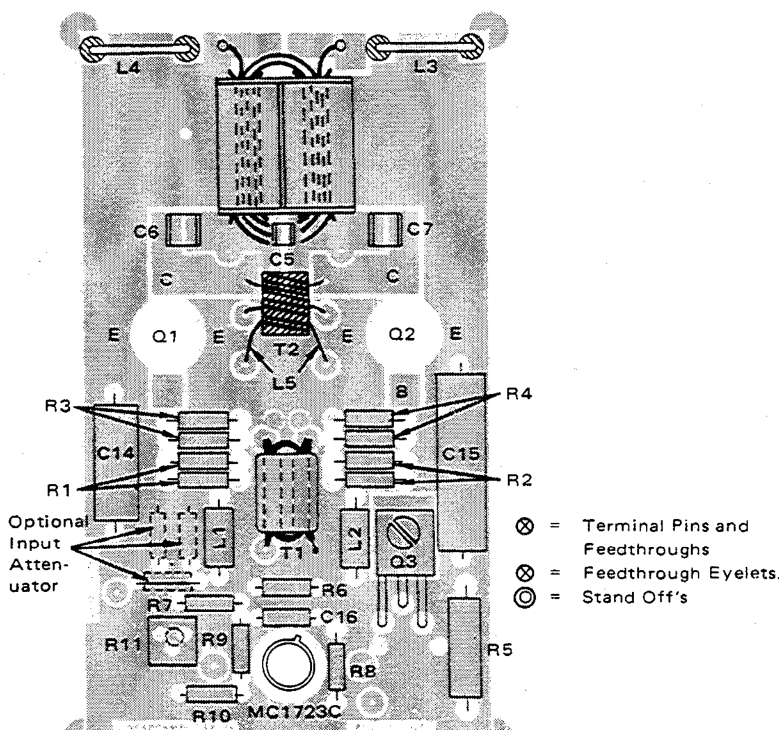
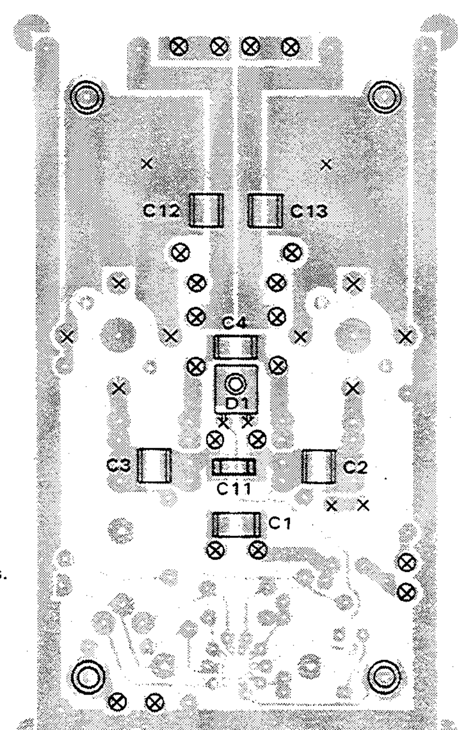


Figure 1 — Collector Efficiency, Power Gain and VSWR vs Frequency

A Stackpole dual balun ferrite core 57-1845-24B is used for T1. The secondary is made of ⅛″ copper braid, through which three turns of the primary winding (No. 22 Teflon® insulated hook-up wire) are threaded. The construction of T3 is similar to that of T1. It employs two Stackpole 57-3238* ferrite sleeves which are cemented together for easier construction. The primary is made of ¼″ copper braid, through which three turns of No. 16 Teflon® insulated wire are threaded for the secondary.

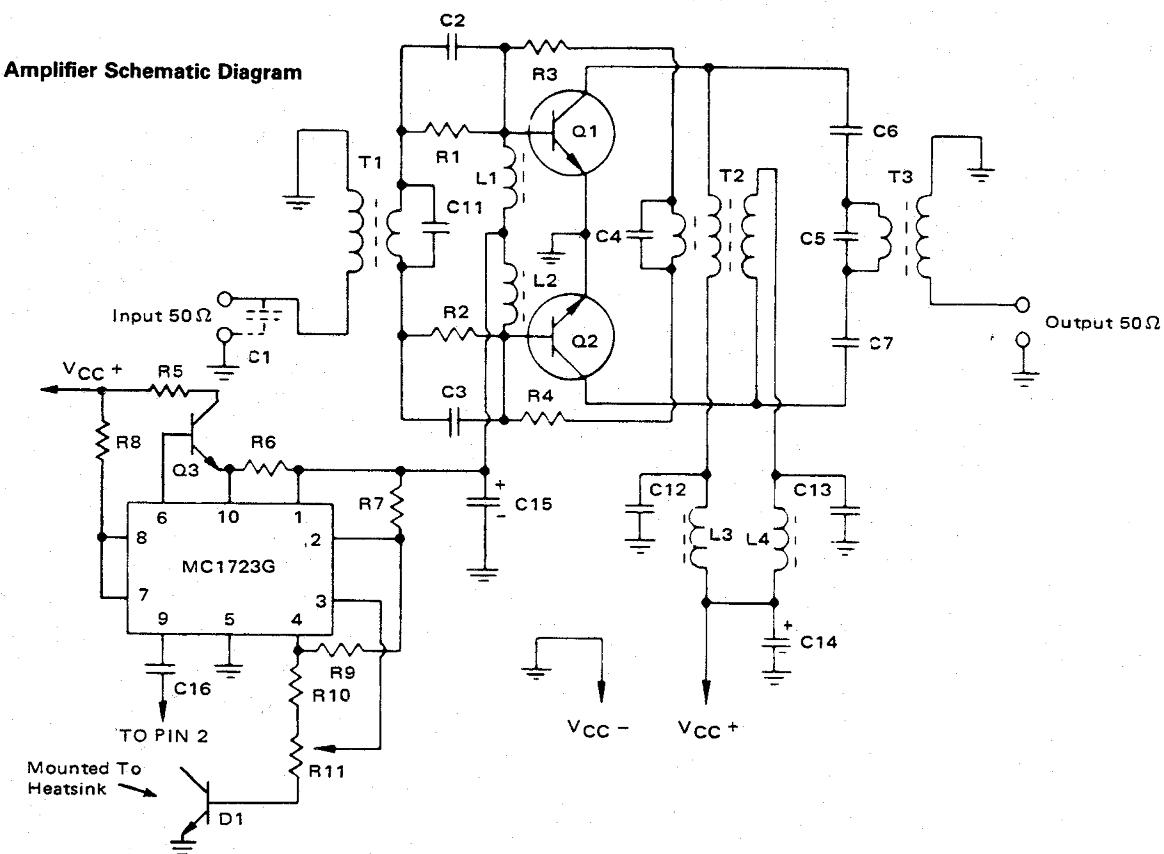


A.



B.

300-Watt Linear Amplifier Schematic Diagram



C1 – 100 pF
C2, C3 – 5600 pF
C4, C5 – 680 pF
C6, C7 – 0.10 μF
C11 – 470 pF
C12, C13 – 0.33 μF
C14 – 10 μF – 50 V electrolytic
C15 – 500 μF – 3 V electrolytic
C16 – 1000 pF

R1, R2 – 2 X 3.3 Ω, 1/2 W in parallel
R3, R4 – 2 X 3.9 Ω, 1/2 W in parallel
R5 – 47 Ω, 5 W
R6 – 1.0 Ω, 1/2 W
R7, R8 – 1.0 k, 1/2 W
R9 – 18 k, 1/2 W
R10 – 8.2 k, 1/2 W
R11 – 1.0 k Trimpot
D1 – 2N5190
L1, L2 – Ferroxcube VK200 20/4B
L3, L4 – 6 ferrite beads each, Ferroxcube 56590 65/3B

Q1, Q2 – MRF422, Q3 – 2N5990
T1, T2, T3 – See text

All capacitors except electrolytics and C16 are chips –

Union Carbide type 1813 and 1225, or Varadyne size 18 or 14, or equivalent

For production quantities, the braid in T_3 may be made of brass or copper tubes with their ends soldered to pieces of PC board laminate. See cover picture and Motorola AN-749 for details.

The bandwidth characteristics of these transformers do not equal those of the transmission line type, but they're much easier to duplicate.

The measured performance of the amplifier is shown in figures 1, 2, and 3 and harmonic rejection data in table I.

Table I. Output harmonic contents, measured at 300-W CW (all test data taken using a tuned output, narrow band signal source).

	2nd	3rd	4th	5th
f (Mhz)	(dB below the carrier)			
30.0	−38	−25	−34	−48
20.0	−33	−13	−43	−45
15.0	−50	−10	−51	−47
7.50	−40	−30	−55	−47
4.0	−37	−22	−55	−37
2.0	−36	−18	−45	−37

*A similar product is available from Fair-Rite Products Corp., Wallkill, N.Y., 12589

®Registered trademark of DuPont

PCB, chips capacitors, transformers T_1, T_2, T_3, and ferrite beads are available from: COMMUNICATIONS CONCEPTS, 2648 N. Aragon Ave., Kettering, Ohio 45420. Telephone: (513) 294-8425.

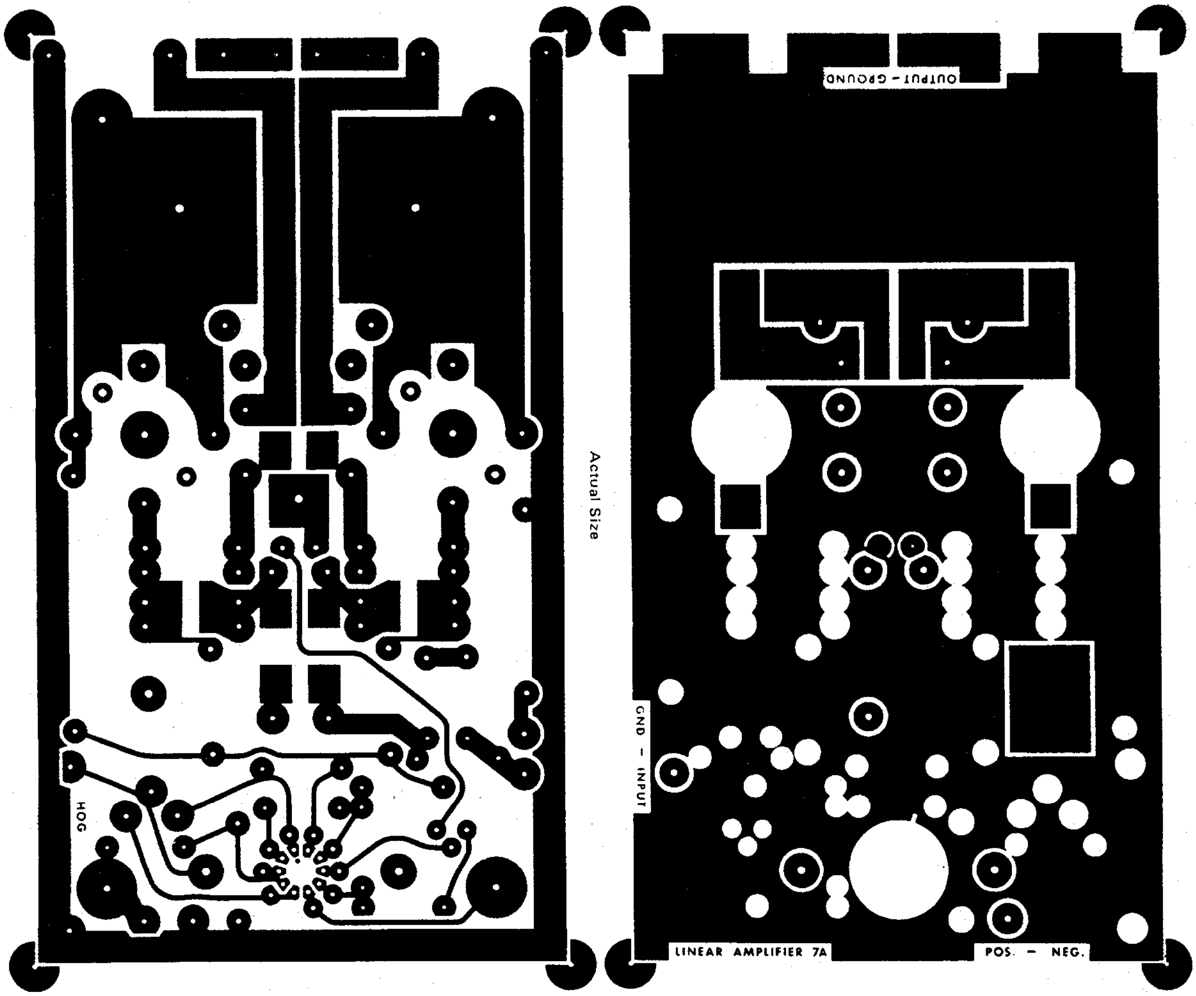


Figure 2 — IMD vs Frequency

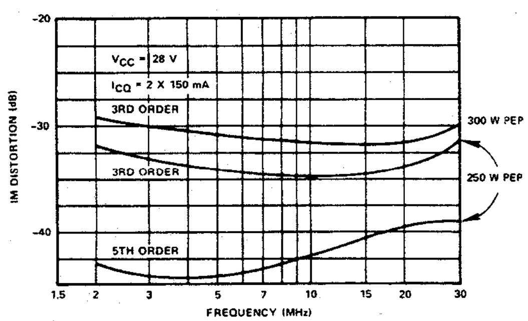
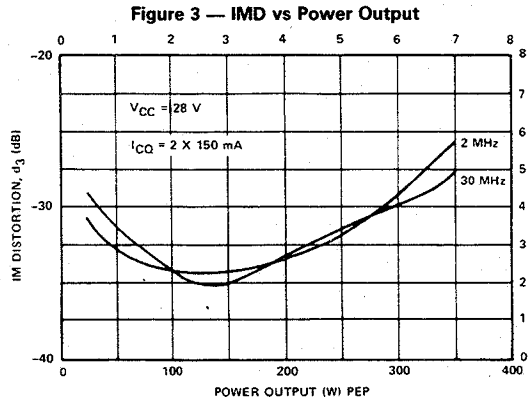


Figure 3 — IMD vs Power Output



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