

A SWEEP-TUBE LINEAR AMPLIFIER



Fig. 1 — Front view of the 800-watt amplifier. An LMB CO-1 cabinet, Simpson 02640 meter, and Kirsh-Kash S-649-70L knobs are used, giving a modern appearance. Coils are changed through the door in the top of the cabinet.

This simple 800-watt PEP sweep-tube amplifier is designed for use on the 160-, 80-, 40-, and 20-meter bands. It is a self-contained unit, complete with power supply and antenna relay. *Note that in some areas of the country this amplifier cannot be used at full input power on the 160-meter band.* The amplifier is designed to be a low-cost companion to any of the single- and tri-band hf transceivers. (A 160-meter transverter is described in Chapter 13.) Because only low-duty-cycle transmission is suitable for sweep tubes operated at high power levels, this amplifier cannot be used for a-m, fm or RTTY service.

Circuit Data

Four 6KD6 color-TV sweep tubes are used in parallel in the circuit of Fig. 2. This grounded-grid amplifier operates in the Class-AB region.

The extremely low plate-load impedance of this amplifier — approximately 500 ohms — requires that special measures be taken to match the plate circuit to the load. A tapped-coil arrangement at L1 aids in obtaining a suitable match. Individual 10-ohm resistors are used in each cathode lead to aid in balancing the tubes for equal resting plate currents. Bias is developed across Zener diode VR1.

K1 provides a “switch-through” feature which permits the antenna to be used during receive. Also, by not activating K1 the transceiver can be used (bypassing the amplifier) while the amplifier is kept ready for use. If the operator does not plan to use this amplifier with a transceiver, the relay contacts can be rewired for antenna changeover — the usual arrangement for separate transmitter and receiver setups.

Construction

The general layout can be seen in the photographs. The equipment is built in an LMB

CO-1 cabinet. Any homemade or commercially built cabinet of suitable size (more than 14 X 12 X 6-inch) may be employed.

Inductors RFC1, RFC2 and RFC3 are hand-wound. RFC3, the plate rf choke, is wound for operation at low impedance over the range from 3.5 to 30 MHz. It was designed with the aid of an RX meter and “looks” like 100,000 ohms on all bands but 10 meters. On ten meters it looks like 25,000 ohms. RFC1 and RFC2 consist of 65 turns of enameled wire on lengths of 1/2-inch diameter ferrite rod. Homemade brass anchors, 1/8-inch wide, are snapped onto each end of each rod and are used as tie points for the ends of the windings. RFC1 and RFC2 are attached to chassis standoff posts by means of plastic cable clamps. L1 is mounted by means of bus-wire pigtailed. RFC3 is wound on a piece of 3/4-inch diameter polystyrene rod. A steatite rod can also be used. (An H. H. Smith 2630 standoff would be suitable, and it has a threaded hole at each end for attaching terminals.)

L2 and L3 are made up as plug-in assemblies so that the amplifier can be used as a single-band unit. Band-switching arrangements would not be practical with the type of tank circuit used. A pi-network tank could be used, and switched, but because of the very low impedance of the plate circuit, the amount of capacitance required for the input and output capacitors of the pi-section tank would be impractical if a satisfactory Q were to result on 160, 80 and 40 meters. The plug-in coils are mounted on James Millen 41305 jack-bar plugs.

C1 is a 160-pF transmitting-type variable taken from a surplus TU tuning unit. Any variable capacitor with similar capacitance and plate spacing (approximately 1/8 inch) can be substituted.

A high-speed cooling fan is used to keep the tube envelopes at a safe temperature. The forced-air cooling also helps to prevent damage to the plates of the tubes from excessive heating. The fan blades should be mounted close to the tubes and should be capable of providing 100 ft³/m or better.

Power Supply

The primary side of T1 has a neon indicator across the line, DS2, to serve as an on-off panel indicator. K2 and the 25-ohm resistor are used when the supply is first turned on (S2 open) to provide protection to CR1 through CR8, inclusive, while the filter capacitor bank charges. The relay will remain open for a few seconds, gradually closing and shorting as the capacitors become charged. U1, a G.E. Thyrector assembly, is bridged across the primary of T1 to knock down any transients above the normal primary level, thus offering protection to the diode string in the secondary circuit.

Eight diodes are used in a full-wave rectifier circuit at the secondary of T1. Each diode has a

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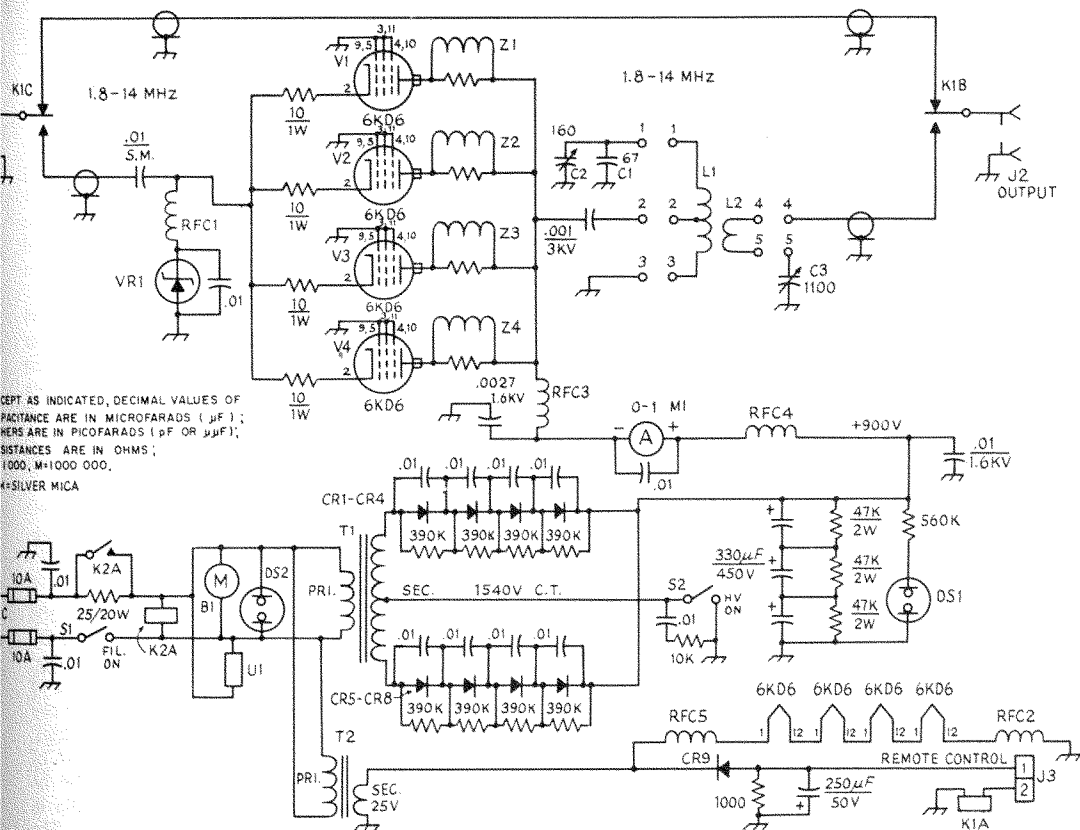


Fig. 2 - Schematic diagram of the linear amplifier. Fixed-value capacitors are disk ceramic unless otherwise indicated. Resistors are 1/2-watt composition unless otherwise marked.

- B1 - High-speed fan (Barber-Coleman DYAF 761-110 with AYFA-403 blades suitable).
- C1 - 67-pF, 2000-V mica or ceramic transmitting type.
- C2 - Transmitting variable, 1/8-inch plate spacing (see text).
- C3 - 3-section broadcast variable, 365-pF per section; all sections connected in parallel (J. W. Miller 2113 or equiv.).
- CR1-CR4, incl. - Silicon diode, 1000 PRV, 1 A.
- DS1, DS2 - Part of S1 and S2, respectively.
- J1, J2 - SO-239-type chassis connector.
- J3 - 2-circuit terminal strip.
- K1 - 24-volt dc relay with 10-A contacts.
- K2 - 117-volt ac relay with 20-A contacts (double-pole unit with parallel-connected contacts suitable).
- L1 - 160 meters - 40 turns, No. 14, 2 1/2-inch dia, tap at 12 turns (B&W 3029).
80 meters - 18 turns No. 12 wire, 2 1/2-inch dia, 3 inches long, made from Polycoils 1774 stock. Tap 6 turns down from C1 end.
40 meters - 12 turns No. 12 wire, 2 1/2 inch dia, 3 inches long, made from Polycoil stock. Tap 3 down from C1 end. 20 meters - 8 turns No. 10 wire, 1 1/4-inch ID, 3 inches long. Tap 3 turns from C1 end.
- L2 - 160 meters - 11 turns No. 12, 3-inch dia, over the ground end of L1 (Polycoil 1779). 80 meters - 5 turns No. 14 wire, 3-inch dia, approx. 3/4 inch long. Mount over outside of L2 at ground end. 40 meters - 3 turns No. 14 wire, 3-inch dia. Mount over ground end of L2.

- 20 meters - 2 turns No. 12 wire, 2 inches dia. Mount over ground end of L2.
- M1 - 0 to 1-ampere dc meter (Simpson 1227 used).
- RFC1 - 65 turns No. 20 enam. wire, close-wound on a 4-inch length of 1/2-inch dia ferrite rod, approx. 200 µH.
- RFC2, RFC5 - 55 turns on Amidon T-130-2 toroid core. Core wrapped with 3M No. 27 glass tape. Both windings on one core, using No. 16 enam. wire.
- RFC3 - See text and Fig. 4.
- RFC4 - 2.5 mH rf choke.
- S1, S2 - Rocker switch with built-in neon indicator.
- T1 - 1540 V ct at 375 mA (Stancor P-8042 suitable. Available from Arrow Electronics, Inc., 900 Route 110, Farmingdale, NY, 11735).
- T2 - 25.2-V filament transformer (Stancor P-8388).
- U1 - Thyrector transient suppressor (G.E. 20SP4B4).
- VR1 - 6.9-V, 50 watt Zener diode.
- Z1-Z4, incl. - Parasitic choke. 8 turns No. 24 enam. wound on body of 56-ohm 1-watt carbon resistor. Use resistor pigtailed as solder terminals for ends of windings. Mount near plate caps.

¹ The pilot lamps and the three rocket switches used here are available from Carling Electric, Inc., 505 New Park Avenue, West Hartford, CT 06110. Order direct if not locally available. Catalog available if requested.

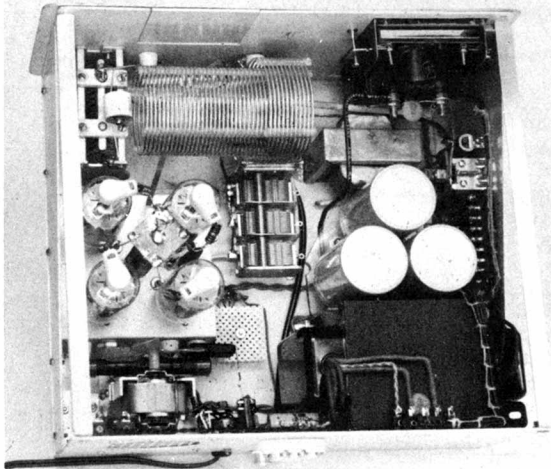


Fig. 3 — The power supply is constructed along the left-hand side. A flat sheet of aluminum is used as a base. The four sweep tubes are mounted on a small 4 X 4 X 1 1/4-inch U-shaped bracket at the upper right. The meter is mounted behind the panel using a Simpson 01253 bezel mounting kit.

resistor and a capacitor across it to offer protection in the event the voltage division across the diodes is unequal. S2 is the HV ON switch and has a transient suppressor across it to prevent damage to the switch when it is cycled.

Three computer-grade capacitors are series-connected at the output of the rectifier to provide 110- μ F at 1350 volts. Each capacitor has a 47,000-ohm resistor across it to assure equal voltage drop. DS2 is the high-voltage ON indicator. Output from T2 is for the filament supply.

Operation

Approximately 50 watts of peak driving power are required to operate this amplifier at its rated 800 watts (PEP) input. If the transceiver being used as a driver has more power output than 50 watts, merely turn the transceiver's audio-gain control down until the power output is correct.

With a 50-ohm dummy load attached to J2, and with operating voltages applied, apply a small amount of drive until an increase in plate current is evident (approximately 100 mA). Adjust C2 until a

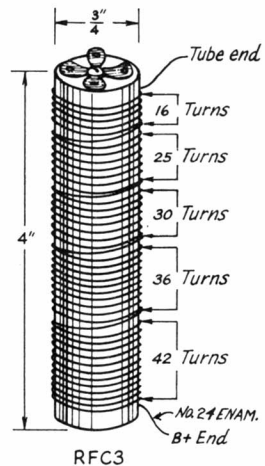


Fig. 4 — Details for winding the plate choke, RFC3.

dip in plate current occurs. Increase drive until 300 mA of plate current is indicated on M1. Quickly dip the plate current and remove drive. Warning: *Do not allow continuous plate current in excess of 100 mA to flow for more than 30 seconds at one time.* Allow 30 seconds for cooling between tests. Next, apply drive until approximately 800 mA of plate current is obtained at dip. C3 should be adjusted for proper loading, making the dip in plate current somewhat broad and shallow. The amplifier is now ready for use and will have a dc input of 800 watts at this setting. Tests made with a spectrum analyzer showed that the IMD (intermodulation distortion) was very good at this power level. The third-order products were down some 27 decibels, and the fifth-order products were down in excess of 50 dB. The second harmonic product was measured at 35 dB down. If the operator does not mind the risk of shortened tube life, the power level can be 1000 watts PEP input. The efficiency of the amplifier is approximately 65 percent.

Other types of tubes can be substituted in this circuit, but few will permit the power level discussed in this amplifier. A good substitute might be the 6LQ6.

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The SS-2000 linear amplifier is designed to handle the legal maximum power input on cw and ssb. Because of the high plate-dissipation rating of the tube there is plenty of safety margin to prevent tube damage in the event of accidental mistuning. This amplifier is carefully shielded and filtered for the reduction of TVI. Though a 3-1000Z tube is used, the popular 4-1000A can be substituted as mentioned later. Both tubes have a maximum plate dissipation of 1000 watts. A suitable power supply for this amplifier (3000 volts) is described in the chapter on power supplies.

Circuit Description

Referring to Fig. 2, the amplifier is connected for grounded-grid operation. Excitation is applied through a switchable pi-section input tuned circuit. This network serves a twofold purpose: It reduces the amount of drive needed, by virtue of proper impedance matching between the exciter and the amplifier. It improves the IMD of the amplifier by providing the exciter with a better load than might otherwise exist. Approximately 50 watts of drive will be ample for the 3-1000Z. Roughly 125 watts