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# The Low-Bander's Special

## Some simple "mods" to an SB-200 amplifier and you're ready to roll on 40, 80 and 160 meters. No need to buy a high-priced linear amplifier just to work "top band"!

By Doug DeMaw,* W1FB

If you're one of those amateurs who wrote to the ARRL Technical Information Service for circuit information on 160-meter amplifiers, this article is for you! To participate in this project it will be necessary to acquire, by whatever upright means possible, a Heath SB-200 or SB-201 amplifier. This can mean a search of *QST* Ham Ads and other such listings for a used-equipment bargain. If you're a skilled orator, some well-executed "lip service" may provide the verbal arm twistin' needed to dislodge a used SB-200 from a friend's shack at a bargain price! The same oral gymnastics can be used at flea markets if need be. The alternative is to buy a new SB-201 kit for top dollar. Even that approach makes more sense than starting an amplifier from scratch with all-new parts!

The components marked with an asterisk in Fig. 1 are needed for the changes described here. The habitual parts scrounger should be more than mildly enthusiastic about this project, as it will challenge his or her skill at the flea market bartering tables and in surplus stores.

The only trauma to be faced is the actual "disembowelment" of the rf section of the SB-200 to be modified. Heath did a superb job of compact packaging when that unit was laid out. A wistful tear or two may form as the cutters and pliers are applied, but that brief sorrow will be more than replaced by joy and pride when the amplifier is finished and ready to use. The end result is a 1200-watt PEP linear amplifier for 40, 80 and 160 meters. This writer elected to eliminate the 20-, 15- and 10-meter bands because the 150-watt exciter has proved to be ample for most operating on these bands.

There are specific FCC power limits imposed for operation on 160 meters. They vary from one U.S. area to another. *This amplifier should be used only as day and nighttime rules permit.* Chapter 1 of *The Radio Amateur's Handbook* lists the 160-meter frequency allocations and power limits for Canada and the USA.

Front view of the modified SB-200 linear amplifier. A small false panel covers the original panel holes and adds a contrasting green color to the white front panel. Green Dymo tape labels identify the control functions.

### Pertinent Thoughts

A skilled innovator could surely make the modified SB-200 work on all of the bands from 160 to 10 meters. The major requirement would be to incorporate a more complicated band-switching method. Some of the fixed-value capacitors in the pi network would have to be switched in and out for the various bands in order to provide the correct LC ratios for proper loaded Q and impedance transformation. An early effort to use the original band switch and enjoy coverage of 160 through 15 meters was short-lived. The switch became badly charred because of arcing, causing a chain reaction that burned out the plate rf choke and several fixed-value capacitors.

The changes described here are based on a loaded Q of 10 (plate tank) and a plate impedance of 2500 ohms, per the Class B amplifier equation

$$R_L = \frac{\text{Plate Voltage}}{1.57 \times \text{Plate Current}}$$

where current is in amperes, $R_L$ is in ohms, and plate voltage is in volts. Based on this data, the $X_c$ of C6 is 240 Ω, the required $X_L$ for the plate inductor is 263 Ω and the $X_c$ of the combined output capacitance of the pi network is 48 Ω. These requirements are met on 80 and 40 meters, but on 160 meters a bit of

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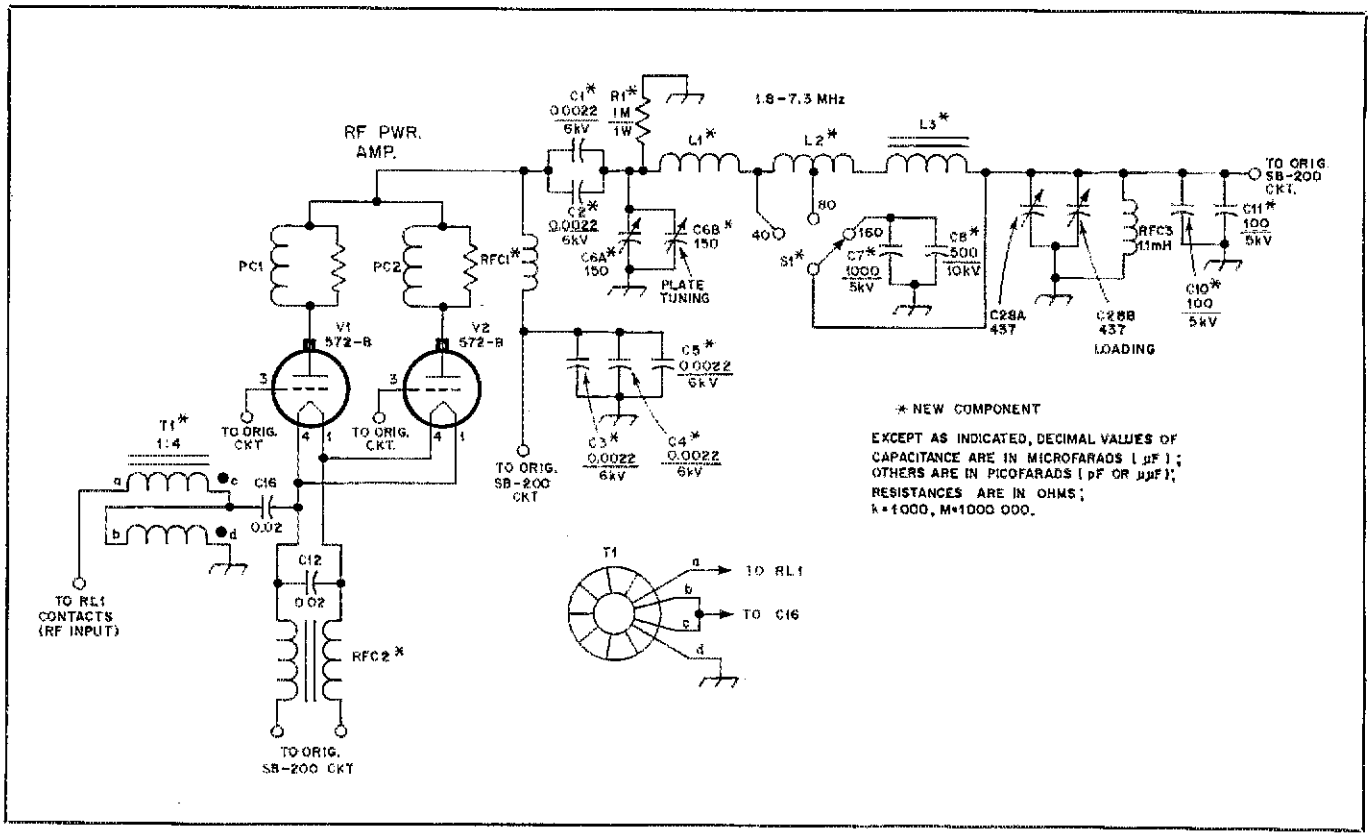



Fig. 1 — Schematic diagram of the revised SB-200 amplifier circuit. Original parts retain their Heath identification numbers. All others have ARRL-assigned numbers.

C1-C5, incl. — Disc-ceramic HV type such as Sprague 60GA-D22.

C6 — Transmitting variable, 300 pF or greater max. capacitance. Split-stator, 150 pF per section, surplus unit used (see text).

C7, C10, C11 — Ceramic transmitting capacitor, Erie type 850 or equiv. Surplus transmitting mica capacitors also suitable.

C8 — TV-type 500-pF HV doorknob capacitor or Erie type 850 unit.

L1 — 6-μH inductor. Use 12 turns of a B&W 3026 Miniductor coil, or form air-wound coil of 12 turns no. 14 wire, 2 in (51 mm) dia by 1-1/2 in (38 mm) long.

L2 — 17-μH inductor, tapped at 6 μH. Use 15 close-wound turns of no. 14 enamel wire on L3 end of coil, and 12 space-wound turns on L1 end of coil. Tap at junction of two halves of L2. Use original Heath coil form (see text).

L3 — See text; 18 turns no. 14 enam. wire on Amidon T200-2 toroid. Wrap toroid core with 3-M glass tape or equiv. before adding winding (5 μH).

RFC1 — Transmitting-type rf plate choke, solenoidal wound. Must be capable of handling 500 mA or greater. An ohmite equivalent was used in this example (part no. unknown, but rated from 160 through 10 meters at 1 A), although a B&W type 800 is suitable.

RFC2 — Bifilar-wound filament choke. Amidon filament choke kit or Amidon 30-61-4 ferrite rod ($\mu_i$ = 125), 4 inches (100 mm) long and 0.5 inch (13 mm) dia wound full of no. 12 enamel wire.

S1 — Single-pole, four-position (90° indexing) ceramic-wafer rotary switch. One position unused. (See text.)

T1 — Broadband 4:1 toroidal transformer. Use three stacked Amidon FT-82-43 (950 $\mu_i$) toroid cores. Winding consists of 15 bifilar turns of no. 22 enam. wire. A hand drill can be used to twist the wires 8 times per inch.

"fudging" was necessary in order to use the 300-pF plate-tuning capacitor (C6) specified in Fig. 1. Because of this, L3 was added to give an extra 5 μH of tank inductance beyond the computed value of 23 μH. A 400-pF variable capacitor could also be used for C6 and would provide the desired 368 pF on 160 meters, thereby eliminating the need for L3. A surplus 500-pF vacuum-variable capacitor would also be an excellent choice for C6. With the 300-pF capacitor (C6) shown in Fig. 1, it would be possible to eliminate L3 and switch in a 100-pF fixed-value transmitting-type capacitor across C6 for operation on 1.8 MHz. This would ensure the optimum LC ratio, but would complicate the band-switching format.

The proper reactance of bypass and coupling capacitors must be observed on all bands. This means that some of the original SB-200 parts just won't "cut it" on 160 meters. The same is true of the plate and filament rf chokes. This is the reason for increasing the values of RFC1 and RFC2, as well as C1 through C5.

## The New Circuit

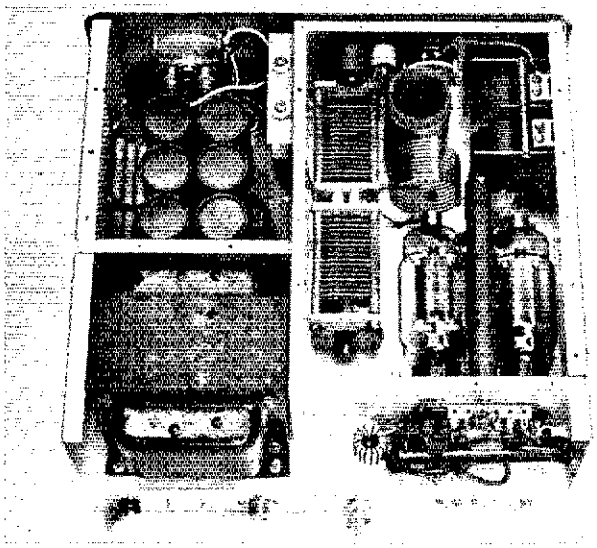
Fig. 1 shows the circuit after the changes have been made. Parts designated with an asterisk have been added; the others retain their Heath identification numbers and were not removed from the SB-200.

There are no changes in the grid circuit of the 572Bs. Similarly, no changes are made below RFC2 in the filament circuit, or below RFC1/C3, C4 and C5 in the plate circuit.

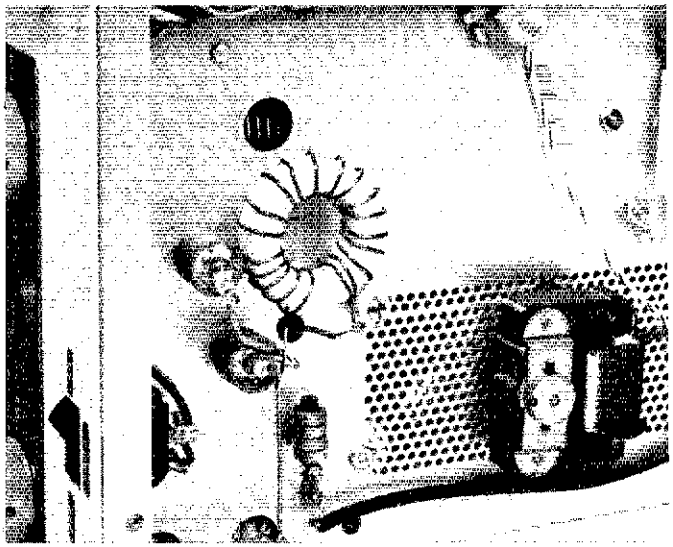
The average input impedance of the 572Bs in grounded-grid service is close to 200 Ω at peak excitation. This makes it practical to substitute T1, a broadband 4:1 transformer, for the numerous band-switched L and pi networks in the original input circuit. Final performance checks show the input SWR of the amplifier at less than 1.5:1 for the three bands, while using T1.

A 1-MΩ resistor (R1) is connected in parallel with C6 for damping high rf peaks. This addition proved beneficial in preventing flashover at the plates of C6 when the amplifier was not coupled tightly enough to the load during tune-up. Had a capacitor with wider plate spacing been available for use at C6, the resistor would not have been needed.

C10 and C11 have been added to provide ample maximum capacitance at the



This photograph shows the placement of the plate-tank inductors (top center). The new plate rf choke is mounted above and between the tubes on the rear deck of the amplifier. The compartment at the lower right houses the 4:1 broadband input transformer (left) and the new filament choke (lower center). The two-section variable capacitor at the left in the upper right-hand compartment is used with the sections in parallel.



This photograph shows the 18-turn toroidal inductor (L3) which is mounted below the chassis near the two high-voltage transmitting capacitors (see text). The T200-2 toroid core is wrapped with 3-M glass tape. This coil is used during operation on 160 meters. The striped piece of wire at the upper right is the new HV lead to the plate rf choke. It is routed through the chassis near the tube sockets.

output of the pi network on 1.8 MHz. Their combined value is low enough so that the network constants are not impaired on 80 and 40 meters. Capacitors C7 and C8 are added for operation on 160 meters. *It is stressed herewith that the modified amplifier is intended to be used only with antenna loads of between 40 and 60 ohms.* If the antenna system presents impedances outside this range, the use of a Transmatch is recommended.

**Physical Changes**

All of the parts except for the tube sockets, fan and C28 are removed from the upper main rf compartment. The exact placement of C6 and S1 will depend on the size of the parts selected for the project. Try to locate a ceramic wafer switch that has large contacts and provides plenty of space between the switch contacts and the metal mounting frame. This will prevent arcing and burned contacts.

The plate spacing of C6 should be 1/8 inch (3 mm) or greater to prevent flashover. A long, narrow capacitor is preferred. Such types are found frequently in surplus stores and at flea markets. Many vacuum variable capacitors will fit into the space available for C6.

A false panel was made from aluminum and affixed to the front panel of the SB-200. It covers the holes through which the old band switch and plate-tuning capacitor were mounted. The plate measures 3-1/2 × 8 inches (89 × 203 mm), is painted Hunter Green and drilled to accommodate C6, S1 and C28. Epoxy cement was used as the bonding agent. The original front panel was painted with three coats of white spray-on enamel before the smaller panel was glued in place. These colors complement the pale gray-green cabinet of the SB-200. Labels were made of green Dymo label-maker tape.

**Other Changes**

The new plate rf choke is mounted above and parallel with V1 and V2. Remember to leave ample clearance for the amplifier top cover. T1 is located on the back side of the vertical partition which supports V1 and V2. L3, C10 and C11 are under the chassis near RFC3. The plate HV lead is routed to the rear of the main rf compartment (below chassis) and brought up to the B+ end of RFC1 through a grommet inserted in a new hole on the main deck of the rf compartment.

The original fiberglass coil form (L2) is rewound with no. 14 enameled wire as indicated in Fig. 1. It is attached to the main chassis near the front panel and S1 by means of two no. 6 spade bolts. The lower end of L2 is connected to L3 by passing a lead through a grommet which is installed near the base of L2. *Note*: If L2 is wound full of turns, it may be possible to eliminate L3 from the circuit. C7 and C8 are attached to the inner front panel just above C6. A ceramic standoff post is placed behind C28 for use as an attachment point for L1. The same method is used below the chassis for supporting one end of L3. The other lead on L3 is soldered to C10.

**Final Comments**

The efficiency of this modified amplifier is 60 percent. Intermodulation distortion is −31 dB and all spurious output suppression is greater than that required by current FCC regulations (better than 40 dB down from carrier value). There is no evidence of excessive component heating, resonance drift or instability. Oh yes, the plates of the 572Bs run red at full power, but don't fret — they turn crimson in the original SB-200 circuit, too! QST

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