73 Review

by William J. Mick K3RVN

Number 6 on your Feedback card

Heathkit SB-1000 Linear Amplifier

Shake and bake test results of a low-priced amplifier from Heath

Heath Company
Benton Harbor MI 49022
Price Class: $700

Whew!

Heath had me worried there a while. For years, hams could count on them as a reliable source of HF linear amplifier kits for the amateur market. Then, to widespread dismay, ham amplifiers disappeared from the product line. Many hams would think twice about building a micro-controlled transceiver, but an amplifier is something comprehensible, probably even repairable, the perfect kit-based station addition. Fortunately, Heath came up with something nice to fill the vacuum. The SB-1000 proves that hams still have friends in Benton Harbor.

The SB-1000 is a classic tuned cathode fed, grounded-grid design using a single 3-500Z power triode. The basic circuit has been an ARRL handbook staple for years. Variations on the 3-500Z theme, with one or two "bottles," have been marketed by numerous manufacturers since the mid-seventies. In fact, under the skin, the design of the Heath SB-1000 is based on the popular AL-80A linear built by Ameritron.

The SB-1000 is not a kit for the first-time kit builder. It contains a 3000 VDC supply, and obviously demands a workmanlike approach in assembly and checkout. Don't rush through this kit, or skip steps, unless you like to live dangerously.

Packing

Everything comes in a fifty-pound box internally sectioned with separate boxes and bags of parts to support each phase of construction. The manual and accompanying foldout charts are of the usual high Heathkit standard. There are also a few pages of errata, mainly typographical and pictorial corrections, that must be integrated with the instructions. None of them appear to be concerned with the kind of detail that endangers life or property.

Subassembly

The amplifier is built on a heavy gauge steel chassis, with an internal partition that separates the RF deck from the power supply and control circuitry. In typical Heath fashion, the first few evenings of construction concentrate on various subassemblies. For me, there were about twelve solid hours of piecework before the thing started to look like the picture in the catalog. In a moment of weakness, I fell victim to the old kit-builder's affliction, cantwaititis. There I was, loosely bolting the chassis' panels together for a preview of the final product on the operating bench. This of course aggravated the condition, as the SB-1000 looks pretty good. The compact size, simple control layout and gray-toned color scheme go very nicely with most modern ham equipment.

PS Rectifier Board

The first piece to build is the power suppy rectifier board, which requires about an hour. This board needs double checks of rectifier diode polarity, as each is soldered in place. The rectifier board was not easy to solder, even though it was pre-tinned. The instructions stated about two or three seconds of heat per joint, but it took twice as long as that to yield sound joints. Fortunately, all the diodes survived despite the additional heat.

The power supply filter board takes another hour or so, and took solder much more easily than the rectifier board. It uses ten large electrolytic capacitors in series, so polarity is crucial. The instructions state that the polarity of each can should be rechecked when the board is complete, but I couldn't do it. The little plus signs on the capacitor tops were out of sight under the board, and not even a dental mirror helped. Builders who don't have a proctoscope may want to mark the sides of the cans before bolting them to the board.

Less than two hours were required to build the boards that handle ALC, power measurement, and meter switching. Construction is fairly simple, except for diode polarity and a couple of multi-colored wiring harnesses.

In contrast to the circuit boards, the input filter unit construction demands patience and dexterity. This unit is a small shielded box that surrounds part of the bandswitch, and it contains a number of slug tuned coils and capacitors. These form individual pi-networks for each band, and there is ample opportunity to connect the wrong bandswitch contacts, or to short some of the longer leads. Liberal use of spaghetti tubing and artful dressing of the numerous wire leads will avoid problems. The Heath assembly pictorials are very clear, and therefore invaluable at this stage. The coil forms snap into holes in the sides of the filter box, and carefully controlled leverage is the only way to install the coils without breaking them.

"Special" RG-58/U

At one stage of input filter assembly the instructions call for a length of small coaxial cable. After twenty-five years of hamming I tend to associate the term "small" coax with something like RG-58/U. In due course a piece of cable marked RG-58/U was found among the SB-1000 parts, but the length wasn't right. A piece of subminiature coax was discovered, and its length did correspond to the instructions, so obviously this was intended for the input circuit.

I've used subminiature 50Ω coax with 100 watt transmitters before, so the use of this really small cable wasn't too much of a surprise. However, it was now obvious that the "large" cable used in the amplifier's output circuit was the piece of RG-58/U. This caused me some concern. Consultations with several other long-time hams didn't offer any comfort. The ARRL Handbook tables show 650 watts and 1900 VDC as the upper (albeit conservatively rated) limits for RG-58/U. In fact, the SB-1000 operating instructions actually recommend that RG-58 and RG-59 feedlines be avoided in favor of heavier RG-8 or RG-11 coax.

I made inquiries of both Heath and Ameritron concerning the use of RG-58/U for the amplifier's output circuit, and received quite similar replies. Although the piece of cable in question is simply marked RG-58/U, it is actually a special Teflon™ insulated cable rated at 2500V. This is not garden variety RG-58, and it is certainly easier to handle than RG-8 when wiring up the amplifier. Cables of this type can be found in a number of modern commercial amplifier products. Its heat resistance is a useful property inside power tube enclosures.

The rear part of the bandswitch assembly handles switching of the plate tank circuit, a tapped pi-network design that incorporates a big tapped toroid inductor for 80 and 160 meters. Doorknob padding capacitors are switched into the circuit on the lower bands, which permits the use of reasonably sized variable capacitors. It's a compact and practical design, and looks a great deal like handbook amplifier designs of recent years, except for the bandswitch.

Bandswitch

Almost every homebrew transmitter, amplifier, or high-power ATU I've ever built has involved a careful search for a heavy duty wide-spaced RF switch for the tank circuits. The SB-1000 bandswitch, a CentraLab designer-type unit, is not typical of handbook amplifiers, which usually specify something like the Millen 51000 RF switch, or a heavy-duty surplus monster. Now, it's hard to believe that I, or the ARRL, have been overbuilding

power amps all this time. On the other hand, neither homebrewers nor the ARRL lab are much constrained by the realities of commercial competition.

In response to my queries, Heath stated that the ceramic bandswitch in the SB-1000 is conservatively rated at 9 amps AC and at 2500V. Furthermore, Heath said that the SB-1000 was run through a rigorous series of FCC tests involving all manner of electrical abuse without any switch problems. Ameritron pointed out that similar switches have been used on kilowatt linear amplifiers of various manufacturers, including Drake, Swan, Dentron, and Heath itself, for some years.

Final Assembly

At this point, I attempted to suspend my prejudices and do the appropriate thing: finish assembly of the amplifier and proceed to beat the hell out of it. The rear panel went together in about three hours, complete with heavy duty primary power relay and RF-filtered AC cable. Phono plugs for external RF relay control, 12V accessory support, and ALC output voltage were also wired up. Also on the rear panel is a safety interlock switch that cuts the AC power when the SB-1000 lid is removed.

The center partition panel holds the two big transmitting capacitors and cooling fan, and is an easy job. Likewise, the front subpanel, with meters and accompanying meter lamps, went together smoothly, right down to the Jackson vernier reduction drives used for the tuning caps. The method used to mount the meters is not very rugged, being a couple of solder lugs at diagonal corners, but it does hold once the panels are bolted together.

Integration of the front subpanel and center partition with the chassis base was not easy. A fair amount of warping and twisting is necessary to make screw holes and capacitor shafts line up properly. Various hardware items must be loosened and aligned to permit smooth control rotation and squaring of all the corners. Another hour or two saw the installation of the power supply rectifier and filter assemblies, and connection of the rear panel. Numerous flying leads and wiring harness ends must be interconnected. Except for minor glitches, like a couple of bad screws, and an out-of-reach solder junction, everything went together pretty much according to the detailed instructions. There was one resistor whose leads could not be trimmed to the specified length because they were already too short.

Fitting of the front fascia and the 3-500Z tube were almost anticlimactic, and after about fifteen hours of construction, the SB-1000 was at last ready for testing.

For obvious reasons, one does not plug in and go at this stage. I spent a good forty-five minutes verifying connections and checking for solder bridges and pinched wires. The rear panel barrier strip was wired for 240V AC input, so the 120V plug was removed and a suitable 240V plug was installed. The lid was set in place in order to engage the interlock, and the unit was plugged into the AC mains.

The thing I hate about high voltage equipment is having to get near that front panel the first time the main switch is thrown. I pushed the SB-1000 power switch with a piece of broomstick and a resounding THUNK! shook the house as the transformer field sucked in the sides of the loose lid. The power supply hummed a bit, but there was no sparking, no arcing, no smoke. The front panel voltmeter showed 3300 VDC, and the 3-500Z glowed encouragingly. Home-brew or kit-built, you get a lot of satisfaction when you first put the juice to the product of your labors and nothing bad happens.

Final Pre-op Tuning

A detailed set of alignment procedures takes the constructor through the tuning of the input matching networks. For this step, the lid must be slid back a fraction of an inch from the front panel while a nylon alignment tool is used to peak up the coil slugs. This is definitely a situation where one hand stays in the pocket. It is worth enlisting a second operator to dictate the instructions, key the exciter for you, and act as safety man. Everything went by the book, and after heating up the Heath Cantenna for awhile, the moment of truth had arrived—it was time for the SB-1000 to speak to the world.

SB-1000 On The Air!

It spoke very well for itself, reaping a lot of favorable comments and no criticisms from any of the stations worked. An FT-102 and an IC-751A were initially used to drive the amplifier, and both had more than enough power to yield full output from the SB-1000. In fact, as the amplifier is rated at 85 watts maximum drive, the exciter carrier levels were reduced slightly to avoid overdriving it. The input tuned circuits are fairly broadbanded, but the drive sometimes has to be brought up a bit when the frequency is away near a band edge.

The SB-1000 has adjustable ALC output of up to twenty volts to help regulate the drive for a clean signal, although this required some fiddling to adjust. The first few months of testing took place in a club environment, and the ALC connection seemed to be unplugged as often as it was connected. It is probably just human nature to resist something which seems to be retarding those satisfying meter swings.

During three months of on-the-air use, there was no evidence of breakdown or other inadequacy in the special RG-58/U, the bandswitch, or even in the antenna relay, which is a plastic insulated AC power type. The antennas used were a well-worn tribander beam and a G5RV multiband dipole, without benefit of an ATU.

The testing environment was one of the worst possible: a club hamshack. A number of hams had the chance to stress it and abuse it, and that's just what they did, mostly unintentionally. Appliance operators accustomed to auto-tune rigs have treated the SB-1000 like a broadband device, changing the bandswitch, but neglecting the tuning controls. Some people take a long time to tune up or forget to watch the grid current meter. In spite of the rough treatment, the amp worked well until halfway through the ARRL DX contest.

What actually happened no one seems to know, except that serious internal arcing was heard on 15 and 20 meters. Examination showed that the safety RF choke at the output of the pi-network was open, but it was hard to tell if this component was the cause or a victim. It was clear that some pretty high RF voltages had jumped from a stator contact on the bandswitch to the metal shaft. There was a great deal of carbon build-up on the rotary wafer, but the rotary contacts were clean. The stator contact, which connects the padding circuit for the plate variable capacitor, was eroded completely. Replacement of the small RF choke and removal of the doorknob cap permitted operations to resume on 80 through 10 meters, but the bad wafer will have to be replaced in order to reenable 160 meter capability.

Despite my original misgivings about the switch, I don't feel that it was the source of the problem. It did work for three months, and it took a contest operation with a lot of different operators to bring about the failure. An insulated shaft might have prevented the arc-over, but after seeing the amount of dust and fuzz collected on the air intake vent and on the floor of the RF section, I am inclined to believe that it was dirt that started the arc.

Top Dollar Value

The price of the SB-1000 is very attractive at about $700. Compared to the big "dollar-a-watt" amplifiers on the market, this amplifier is an economical way for a guy who isn't QRO-crazed to boost his signal when he needs to. It is not built to be indestructible, but it isn't priced like a continuous service amp, either. While the amplifier is advertised as covering 160 to 15 meters, any technically competent ham will be able to figure out how to make it work on 10 meters as well. If you know what you're doing, you won't even have to buy any additional parts.

One thing Heath might do is to review the list of required tools, which seems to be the same list whether the kit is a simple noise bridge or a high power antenna tuner. I found several points during construction where a 25 watt soldering pencil was not hot enough for the job. A 100 watt gun was needed for some of the heavy power supply and tank circuit connections, and it was necessary to use a 250 watt gun when soldering the safety RF choke in the output circuit to the bandswitch frame.

Conclusion

Heath, traditionally the friend of the ham on a budget, has once again provided a cost-effective piece of gear that will do both the manufacturer and the constructor credit. Thanks are due to Denton Bramwell at Heath and Tom Rauch at Ameritron for their courteous and helpful responses to my questions. Although I personally would have selected heavier components for the bandswitch and antenna relay, I am satisfied that the supplied parts are adequate for the job. The club members are enthusiastic about the SB-1000, and while we have asked more of the amp than we should have, we look forward to a lot more heavy use in the future. 73