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The Heathkit SB401 Transmitter

Companion to the SB301 receiver reviewed here last month, the SB401 is, like its partner in receiving, a modified and improved version of an older piece of gear, in this case the SB400, an exciter which lost no time in establishing a good reputation.

Frequency coverage is from 10 to 80 meters in eight 500 kHz segments, four of which are required for the full spread from 28 to 30 MHz. The operator has a choice of upper or lower sideband and vox activated CW on all frequencies.

Circuit

Make no mistake—nothing's missing from the SB401. A fistful of controls make you master of any situation. Tracing out the circuit will make this clear.

Audio input, either high-impedance mike or phone patch, is applied to the grid of the preamplifier, half of a 6EA8. Audio response is shaped to restrict bandwidth to 350 to 2450 Hz, plus or minus 3 dB. The amplified signal goes through a capacitor and level control to the other half of the 6EA8, a cathode follower.

In either of the SSB positions—upper or

lower—audio from the 6EA8 is also applied through the vox gain control to the vox amplifier. When operating CW, however, a 1000 Hz sidetone is generated by a 6J11 tone generator and amplified by a 6D10 tone amplifier; this feeds the grid of the vox amplifier, allowing vox to be used in all modes. Output from the vox amplifier is rectified by a diode and coupled to the grid of the relay amplifier. Vox sensitivity and drop-out time are adjustable, as is anti-vox level.

In addition to keying the vox amplifier, the tone oscillator also provides a monitoring sidetone. This can be obtained by feeding the receiver audio into a rear panel jack on the transmitter, then plugging the station loudspeaker into another jack. Thereafter, the received signal is heard normally until the transmitter is activated; at that point, the receiver is muted and the sidetone is heard in the speaker instead, each time the key is closed—a very convenient arrangement which will be appreciated by CW hounds. A level control inside the cabinet, but easily accessible, adjusts sidetone volume.

A triple-triode Compactron, a 6AV11, is used as follows: one triode is the lower

sideband carrier generator, at 3393.6 kHz. Another triode section is for the upper sideband carrier at 3396.4 kHz, and in the CW mode, uses another crystal at 3395.4 kHz. Only that triode selected by the mode switch receives plate voltage. The third triode is a cathode follower in all modes.

Audio from the speech-amplifier cathode follower and carrier from the sideband generator are fed to a diode ring balanced modulator whose output is the sum and difference of the audio and carrier frequencies. When operating on CW, a small dc voltage upsets the balance of the modulator, producing output on the CW carrier frequency.

The signal is then coupled through a transformer to the grid of a 6AU6, which isolates the balanced modulator from the crystal filter and provides for the proper impedance matching. This stage is also partially controlled by ALC (automatic level control) voltage which will be mentioned later. From the isolation amplifier, the signal next goes to a 2.1 kHz crystal lattice filter, emerging to be coupled to the grid of the 6EW6 mixer.

The SB401's VFO operates over a range of 5 to 5.5 MHz, its output passing to the cathode of the 6EW6 mixer, which produces the sum and difference of the VFO and previously generated frequencies. The sum frequency is then coupled through a bandpass coupler (8.395 to 8.895 MHz) to the grid of the heterodyne mixer, another 6EW6.

The triode portion of a 6AW8 is a heterodyne oscillator whose plate voltage is regulated, and whose frequency is determined by one of the eight switch-selected crystals. Its output is also coupled to the grid of the 6EW6 heterodyne mixer. In passing, note that the sole function of the pentode section of the same 6AW8 is to amplify the heterodyne oscillator input from the companion receiver, the SB301, when operating transceive. Only when the mode switch is in the "transceive" position is plate voltage applied to this part of the tube. In the "independent transmit" position, voltage is applied instead to the plate of the 6AW8 heterodyne oscillator.

The signals from the bandpass coupler and heterodyne oscillator are mixed in the 6EW6 heterodyne mixer. Only the difference frequencies reach the grid of the 6CL6 driver tube. A trap in the driver grid

suppresses a spurious signal at 8.6 MHz which might otherwise appear in the output on the 7 MHz band.

Driver output is applied to the grids of a pair of 6146's in parallel, operating in Class AB₁. An internal pot sets bias at -50 volts to hold the no-signal plate current at 50 mA.

Peak driving voltage for the finals is variable with the CW level control, which is in tandem with the microphone gain on the front panel. In SSB operation, the limiting action of the ALC circuitry also affects the driving voltage.

A conventional pi network couples final output to the antenna. Impedances of approximately 40 to 150 ohms can be matched. A built-in relay automatically transfers the antenna from the transmitter to the receiver.

SB-401 Specifications

Frequency Coverage:	3.5 to 4.0; 7.0 to 7.5; 14.0 to 14.5; 21.0 to 21.5; 28.0 to 28.5; 28.5 to 29.0; 29.0 to 29.5; 29.5 to 30.0 MHz.
Emission:	Selectable upper or lower sideband, CW.
Input power:	180 watts PEP SSB, 170 watts CW.
Output power:	100 watts on 80 through 15 meters; 80 watts on 10 meters.
Output impedance:	50 to 75 ohms.
Frequency stability:	Less than 100 Hz drift per hour after 20 minute warmup period. Less than 100 Hz drift for 10% changes in line voltage.
Sideband generation:	Crystal lattice filter. Carrier suppression 55 dB down from rated output. Unwanted sideband suppression 55 dB down from rated output at 1000 Hz and higher. Third order distortion 30 dB down from rated PEP output.
Dial accuracy:	Visual accuracy within 200 Hz on all bands; Electrical accuracy within 400 Hz on all bands after calibration to nearest 100 kHz point.
Features:	Noise level at least 40 dB below rated carrier; audio frequency response from 350 to 2450 Hz; 10 dB audio compression; high impedance microphone and phone-patch inputs.
Power requirements:	105-125 Vac, 50/60 Hz. 80 watts in standby; 260 watts CW (key down).
Size and weight:	14 $\frac{7}{8}$ " x 6 $\frac{5}{8}$ " x 13 $\frac{3}{8}$ ". 26 $\frac{1}{2}$ pounds.
Price:	\$285. (Optional crystal pack \$29.95).

In either LSB or USB modes, when the final tubes are driven into grid current, a voltage appears at the junction of a resistor and capacitor in the final grid circuit. This voltage, which follows the audio peaks, is rectified by a pair of diodes and appears on the grid of the 6AU6 isolation amplifier as a bias. Thus, should the finals be overdriven, gain is reduced immediately to prevent splatter. In one of its several switchable positions, the panel meter displays the ALC voltage. By keeping an eye cocked at it, drive may be effectively controlled by holding voice and gain at the level where the needle stays where it's supposed to.

The meter also reads final grid and plate current and plate voltage, as well as relative output and is very useful in tuning up and operating within the proper parameters.

The lineup is completed by a solid state power supply furnishing 720 volts dc under full load of 250 mA. Lower voltage dc—250 volts—is also provided for other stages, and there is —170 volts of bias too.

Comparison with the SB400

The major difference between the new rig and its rather young ancestor is "instant transceive". Owners of the SB400 will recognize the value of this new feature immediately; you no longer have to open the cabinet and change the output cable from the VFO to switch modes. It was never a big deal to do so, but there's no doubt that the convenience is well worth having. So many SB400 owners have home-brewed conversions that will do the same thing that a number of articles have already found their way into the magazines. At least one unpublicized version this writer knows of (K2UJ fathered it) was based on the fact that the heterodyne oscillator is activated only in the transceive mode. The plate voltage was picked up at a convenient point to power a relay that performed the actual switching of cables. Other schemes have been used successfully.

An added driver coil is an important but less noticeable improvement which results in more 10 meter drive. The single driver coil in the SB400 was tuned for 28 MHz. As a result, drive was insufficient in the upper reaches of the band. Now, with the extra coil peaked at 29 MHz switched into the circuit better results are assured.

The VFO mixer stage, although still us-

ing a 6EW6, has been completely revamped. Even a casual comparison shows the difference at once. A 21.1 MHz trap is now included in the circuit. There are many minor revamps elsewhere; the mere fact of their existence is a pretty good indication that the boys at Benton Harbor are satisfied with nothing but the ultimate and continue to improve their product even when it is already well accepted.

As further evidence of this thinking, the SB401 has a 680 ohm resistor inserted in the screen voltage supply to the finals. It has been added because it reduces the already acceptable distortion products figure by 3 to 4 dB more.

Although the SB400 was designed to operate independently or transceive with the SB300 receiver (which it will also do with the new SB301), it was sold only as a complete unit. With the advent of the SB401, however, Heath has changed their marketing strategy and made the rig even more of a bargain for those who own the receiver. The new model is available complete, as before—which is what you'd need to use it with any other receiver—but, if you own either the SB300 or SB301, you can buy the transmitter for less without the crystals which are sold as a separate accessory.

The new transmitter's VFO has been modified, just as it was in the transition from one receiver to another. Minor circuitry changes and use of an industrial type 6BZ6 instead of the old 6AU6 is the story. At the risk of boring those who may have read the review of the SB301, this seems to be gilding the lily, because the original VFO was rock steady. The new one is at least as good, if not better.

Other minor but noticeable changes . . . a different type of socket on the rear panel to provide line voltage ac to operate external relays; the use of two terminal boards smaller than used in the SB400 for below chassis parts mounting, cleaning things up nicely.

Construction, alignment and operation

A total of 37½ hours was spent building the transmitter, including about two hours for photography. Alignment, for which you need a VTVM with an rf probe, a ham band or general coverage receiver, and a dummy load, took about 3 hours more.

Would-be builders may benefit from these suggestions:

Before soldering any connections from the cable harnesses, lay them in the most advantageous position. Twisting them here and there will make for a neater job. Take this precaution—where the manual specifically instructs you not to shorten leads breaking out of the harness, don't. Hear and obey!

Make every effort to achieve proper alignment of the dial mechanism. Set up right it is as smooth as the expensive spread; if not, it shrieks, groans and otherwise suffers.

Once construction, alignment and calibration are finished, you can begin to enjoy the fruits of your labor. This transmitter is everything you could want. SSB buffs will be proud of their clean, splatter-free signals, excellent suppression, freedom from drift, and natural audio quality. The vox is smooth and can be adjusted from instant dropout to holding in long enough so that you'll never know you worked Don Miller. This is no gag—I found myself cutting its hold-in time for fear I wouldn't hear his rapid-fire comebacks.

Brasspounders will revel in the clean, chirp free T9X note, to say nothing of the convenience of the built-in sidetone and vox-activated break-in keying. The scope in my shack displays a signal which is shaped good, like a CW signal should.

Add the undeniably good looks of the package, the fractional kHz readout, and you've got quite a piece of equipment.

Final comments concern transceive operation with the SB300 or SB301. Numerous interconnecting cables are required, as expected, but three of them—those which bring the VFO, BFO and heterodyne oscillator signals into the transmitter—must be cut from RG62 coax cable to exactly 2 feet. The cable is supplied with the kit.

When the transmitter and receiver are interconnected and CW operation is desired, the transmitter's mode switch should remain in the "transceive" position at all times, whether actually transceiving or operating split frequency. If the mode switch is set instead to the "transmit" position for CW, a constant beat note is heard in the receiver. This isn't too clear in the manual and it took a personal discussion with the Heath engineers before it was cleared up. As a result, they have issued a bulletin to clarify the matter, and are including a revision in current production. This also applies to the SB300/400 combination. . . . W2JDL

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