The Heathkit SB-10

REVIEWED BY R. F. STEVENS (G2BVN)*

THE Heathkit SB-10 Adaptor was designed specifically for use with the American "Apache" transmitter to enable that equipment to be used for single sideband suppressed carrier emission on all bands from 3·5 to 28 Mc/s. An adaptor differs from an exciter in that it contains no carrier generator, but the use of the SB-10 is not confined to operation with the "Apache," and it can be readily employed with r.f. driver and power amplifier units which may be available in existing a.m. equipment. Alternatively these units may be constructed and used in conjunction with the SB-10, the whole forming a relatively inexpensive s.s.b. transmitter.

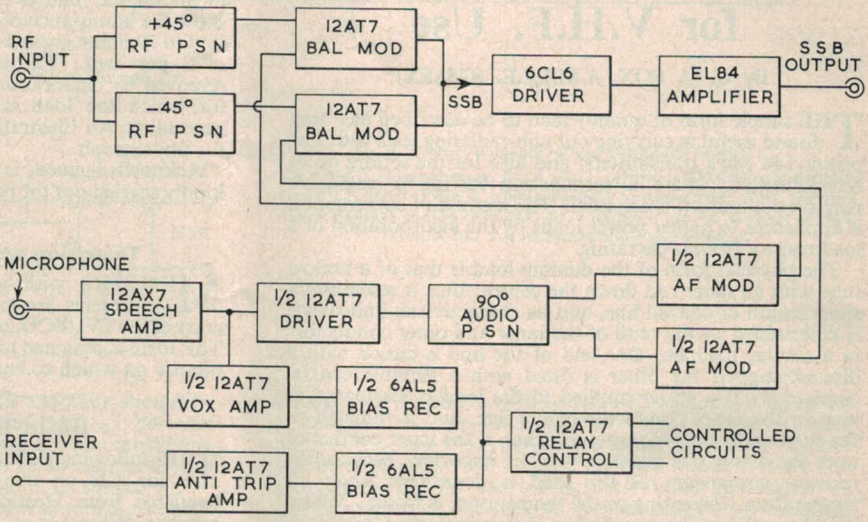
The Adaptor, which measures 10 in. high by 7 in. wide and 13 in. deep, contains the following circuits: (*a*) r.f. balanced modulators (two 12AT7), r.f. driver (6CL6) and linear r.f. amplifier (EL84); (*b*) speech amplifier (12AX7), audio driver (half 12AT7) and a.f. modulator (12AT7); (*c*) voice control voltage amplifier (half 12AT7), anti-trip amplifier (half 12AT7), bias rectifier (6AL5) and relay control valve (half 12AT7).

The r.f. input to the Adaptor should be at low impedance and less than 3 watts of power at the working frequency is required. The input passes through a broadband r.f. phase shift network of the passive type which has five switched positions for the bands 3·5 to 28 Mc/s. The r.f. signal is divided into two components which are each at 45° to the input, i.e. 90° to each other, and which drive in parallel the grids of the two balanced modulators. The anodes of the 12AT7s are connected in parallel push-pull and the output signal, in this case the carrier, is balanced out. The cathodes of the balanced modulators are returned to earth through two potentiometers mounted on the front panel which comprise the carrier null controls.

The speech amplifier is designed for high impedance input and after amplification by two resistance-capacity coupled stages the a.f. signal passes to a *R*/*C* network which divides the signal into two components separated from each other by 90° over the range 300 to 3,000 c/s. The phase shift network used in the unit under review was the Barker and Williamson type 2Q4. The two a.f. signals drive the grids of a 12AT7, the anodes of which are in push-pull. A pre-set potentiometer functioning as the audio balance control is located in the cathode circuit of this valve and is used to ensure that the output to each of the transformers in the anode circuit is equal. These transformers provide a.f. voltages of the required phase difference which are applied to the grids of the two 12AT7s forming the balanced modulators. A switch in this grid circuit enables upper, lower or double sideband operation to be selected by applying the a.f. voltage in the correct phase relationship.

The s.s.b. signal from the balanced modulators is amplified by a 6CL6 class A driver with a broadband output circuit, and capacity coupled to the grid of the EL84 class A amplifier which furnishes low impedance output through an all-band pi-network circuit. A small capacity is used to couple in a little of the output to a r.f. voltmeter circuit (panel mounted meter) which is used for adjustment and tuning. The maximum output from the EL84 is approximately 10 watts p.e.p.

The SB-10 contains its own voice control and anti-trip circuitry and the output of the speech amplifier is applied to the grid of the VOX voltage amplifier. Similarly, output from the receiver is applied to the anti-trip amplifier, and the output from this is coupled to the cathode of a bias rectifier (half 6AL5). The plate of the VOX voltage amplifier is applied to the anode of the second half of the 6AL5, the cathode of which is directly coupled to the grid of the relay control valve (half 12AT7). The relay will be operated by sounds reaching the microphone, but when the anti-trip bias is correctly set, audio from the receiver will not cause the relay to trip. The relay contact terminations are brought out to an insulated strip on the rear apron and allow r.f. driver keying, receiver loudspeaker muting and aerial relay operation.



Block diagram of the Heathkit SB-10 s.s.b. Adaptor.

The front panel controls of the Adaptor comprise: two carrier null potentiometers, a five-position bandswitch, sideband selector switch, balanced modulator tuning, r.f. amplifier tuning, audio gain, standby-VOX-manual switch and microphone socket. The rear apron carries the power input socket, relay terminal strip, sensitivity controls for the VOX and anti-trip circuits, and r.f. input and output sockets. There are also two pre-set potentiometers on the chassis of the unit for audio balance and phase balance.

The power requirements are 6·3 volt a.c. at 3·5 amp., and 85 mA (average) at 350 volt d.c., the h.t. current swinging up to a maximum of 140 mA on speech peaks. The figure of 350 volts is that given in the manufacturers' handbook, but it has been found in practice that this may be reduced to 260/270 with very little reduction in output and considerably less heat generation. The power supply used with the Adaptor should have good dynamic regulation and it is recommended that the output capacitance should be of at least 64μF.

The construction of the unit occupied 16 hours in irregular periods of one hour or so, and was carried out strictly according to the manual supplied, in which the instructions were concise and clear, although it is advisable to make at least two readings of the more complicated sections. As might be expected from a Heathkit unit, the components were of good quality and the external appearance was attractive.

Member, Technical Committee

Operation

R.f. drive for the SB-10 was obtained from a " Miniciter " made by the Minimitter Co. Ltd., the output of which was altered to low impedance to allow connection to the Adaptor by coaxial cable. The linear power amplifier employed two TT21 valves in parallel and was described in the R.S.G.B. BULLETIN for June 1960. There is, however, no reason why other equipment capable of supplying the necessary r.f. drive should not be used, bearing in mind that it is essential that the stability of the v.f.o. must be of a high order. It is not a difficult process to modify an existing a.m. class C p.a. for class A or AB1 operation, and details will be found in the sideband handbooks by W6TNS or the A.R.R.L.

The initial testing and adjustment was carried out according to the instructions in the manual, but the suppression of the unwanted sideband was considered insufficient, although possibly this may be partly accounted for by the deficiencies in the oscilloscope used. Subsequently, the audio and phase balance controls were adjusted using a valve voltmeter and oscilloscope in the manner described in the fault tracing section of the manual. The settings thus obtained were checked by inspection on a panadaptor using a very narrow sweep. It has been found that alignment of fundamental frequency phasing-type generators, such as the SB-10, using a s.s.b. receiver is often unsatisfactory owing to radiation from the r.f. driver on the carrier frequency. After completion of the initial adjustment the carrier suppression was found to be slightly less than 50db and the suppression of the unwanted sideband approximately 35db.

The output from the Adaptor is amply sufficient to orive the linear amplifier to full output, and when using a D104 crystal microphone it is not necessary to advance the audio gain control more than the first 90° of its travel. It cannot be emphasized too strongly that it is essential to place quality before quantity, and if the SB-10 is overdriven, either by excessive r.f. excitation or too high audio input, then the output will be severely impaired which may result in interference to stations on adjoining frequencies.

To produce a clean and acceptable s.s.b. signal it is necessary to assemble carefully this piece of complex equipment and to thoroughly check the results of the alignment. For the perfectionist there are modifications which can be done to improve the performance, and these may form the basis of a future article, but there is no reason why the SB-10 should not be the means of generating a s.s.b. signal that is acceptable in quality with the additional advantage that the cost can be kept to a minimum by the utilisation of existing equipment.

The SB-10 Adaptor is made in U.S.A. and is obtainable from Daystrom Ltd., Gloucester.

Notes on the Use of the CV138 in Exciters and Low Power Transmitters

THE well-known television r.f. pentode amplifier type CV138 (EF91, 6AM6, 8D3, Z77) does not appear to be used to an extent justified by its performance. Indeed, many descriptions of amateur equipment specify larger and more expensive valves in positions which could equally well be filled by this valve with its high slope and gain. In such applications as crystal oscillators, crystal oscillator-frequency multipliers, low power amplifiers and frequency doublers or treblers the CV138 will be found to give sufficient output for most applications.

The purpose of the data given here is to indicate how well the valve will perform under correct conditions. From Fig. 1 and Table 1 it will be seen that as an r.f. amplifier, outputs of over 1·2 watts can be obtained up to 150 Mc/s, so the valve could usefully be employed in low power 2m equipment. A pair in push-pull give 2·25 to 2·5 watts output for 6 watts input. As a frequency multiplier an output of about 0·8 watt can be obtained at frequencies of the order of 150 Mc/s when operating as a doubler; as a trebler the same power can be produced at up to 100 Mc/s.

It is clear that the CV138 can be employed in the early stages of most amateur equipment used both on the h.f. bands and for 2m and 70cm. Similar results may be obtained using the fully screened versions commercially known as the EF80, Z719, 6BX6 and 6BW7. In these cases the valve is fitted with B9A base and a larger bulb.

TABLE 1

Service	F_{in}	F_{out}	I_a	I_{g2}	I_{g1}	P_{out}
Amplifier	60	60	11·5	3·2	1·5	1·9w
	120	120	11·5	3·2	1·7	1·6w
	200	200	9·7	3·2	1·9	0·4w
Frequency doubler	30	60	10·0	3·2	1·5	1·5w
	65	130	10·0	3·2	1·6	1·1w
	90	180	9·0	3·2	1·8	0·25w
Frequency trebler	20	60	10·5	3·2	1·6	1·1w
	30	90	10·0	3·2	1·7	0·9w
	50	150	9·0	3·2	1·8	0·2w
Operating Conditions: V_a, 300 volts, V_{g2}, 250 volts, V_{g1}, 20 volts						

It should be noted that the screen input is the limiting factor of input power and should not be exceeded.

Some of those present at the Grafton Radio Society's Annual Constructors' Competition for the G3KGC Cup. Left to right, P. Solder (G5FA) and S. H. Iles (G3BWQ), judges: R. Morgan (G3KGC), donor: D. Sloan (G3ONS), winner: R. Howel (G3KRH), second and P. Beresford (G3AFC), third.