Modulating the DSB Transmitter

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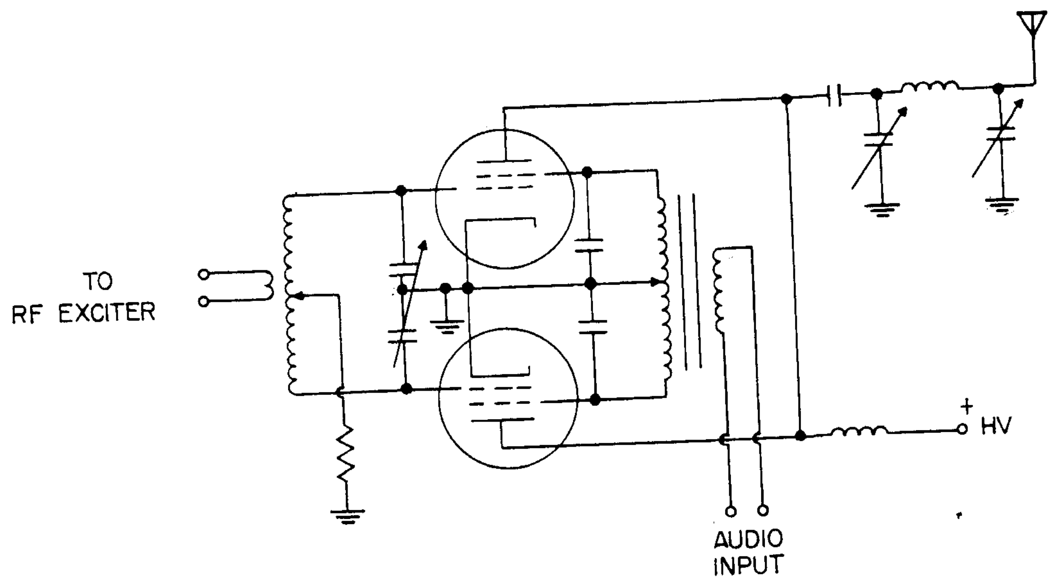


Fig. 1—Schematic diagram of high level modulated DSB transmitter.

With the increasing popularity of double-sideband operation on the amateur bands there appears to be a need for some information as to how to obtain optimum performance from the DSB transmitter. Most operators who have tried DSB have found that it has a few features which make it more desirable than either AM or SSB. It suppresses the carrier; has inherent diversity; is much simpler to build and operate than SSB; allows greater intelligence power output from the transmitter; and, when received on a synchronous detection receiver[1], it is a genuine pleasure to use.

There are two convenient methods of converting to a DSB transmitter. One method involves DSB operation of phasing type exciters in existing single-sideband stations. This is easily accomplished with the Central Electronics' exciters, and other similar equipment, by operating in the AM mode with the carrier suppressed by the CARRIER BALANCE control. The second, and least expensive method, is the high level balanced modulator circuit described by W2CRR[2]. A schematic diagram of the transmitter circuit is shown as fig 1. The circuit utilizes two screen-grid tubes driven in push-pull with the plates connected in parallel. The audio is supplied in push-pull to the screens. The chief advantage of this method is its ease of adjustment which is a result of its simplicity.

It will be found that proper adjustment is as important in the DSB transmitter as in the SSB transmitter. Correct adjustment of a DSB transmitter of either type can be indicated with a single audio tone and an oscilloscope. Only one tone is required in order to get the familiar "two-tone" test pattern since two sidebands are generated.

A single tone envelope for the DSB transmitter is shown in fig 2. It can be seen that the pattern is identical to the two-tone equal amplitude test envelope in the SSB transmitter. Just as with SSB, the drive and final amplifier loading are adjusted to give the highest power output consistent with linearity. The "Bowtie" pattern presents a more convenient method of indicating alignment of the DSB transmitter. The bowtie corresponds closely to the trapezoidal pattern used in the adjustment of AM transmitters and is obtained with the same oscilloscope connections. Audio is fed to the horizontal plates and double-sideband rf output is fed to the vertical plates. Fig 3 is the pattern that will be obtained with a well adjusted DSB transmitter. Fig 4 shows some of the patterns indicating incorrect transmitter adjustment.

Fig 4a indicates either that the coupling on the final amplifier should be increased or that the audio driving voltage should be reduced. Fig 4b is what will be seen if tubes which need screen bias are operated with too much bias voltage. Fig 4c shows the effect of unbalance in the balanced modulator.

Note the "one-tone" test picture in fig 2. A most likely observation is that the envelope is not filled, or that the average power is less than the peak power. In fact the average power is one-half the peak power. This means that if a tone modulated DSB transmitter was measured as delivering 100 watts of average power to the antenna, the peak power would be 200 watts. This fact may be used to a great advantage if speech clipping is employed. When the peaks of an audio waveform are clipped, the effect is to raise the average power. The clipped speech is passed through a lowpass audio filter to suppress the higher order harmonics, or "splatter," generated in the clipping process. In effect, if the DSB transmitter is modulated with clipped speech it is modulated with square waves. Fig 5 is the DSB envelope displayed on an oscilloscope with a clipped sine wave as a modulating voltage. It is seen that the envelope has nearly constant amplitude or that the peak and average powers are nearly equal. It can be con-

[1]J. K. Webb, "A Synchronous Detection Adapter for Communications Receivers", *CQ*, June 1957

[2]J. P. Costas, "Single Sideband: Is It Really Better Than Amplitude Modulation", *CQ*, January 1957

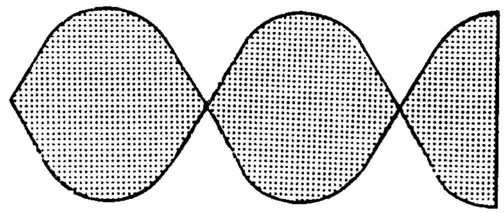


Fig. 2—Oscilloscope pattern showing envelope of a single tone modulated DSB transmitter.

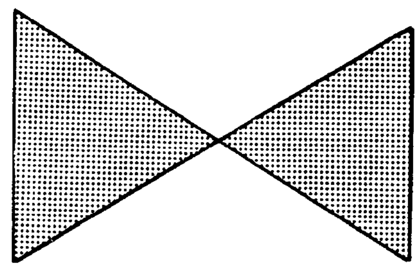
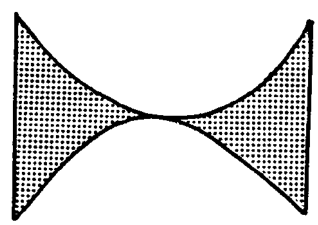
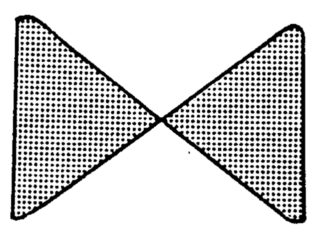


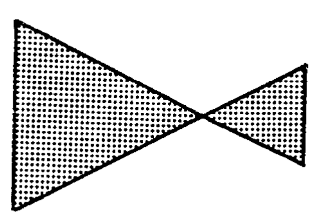
Fig. 3—Bowtie scope pattern obtained with properly adjusted DSB transmitter.



a—Output load impedance too high, or too much audio drive.



b—Excessive bias on screens.



c—Balanced modulator not balanced.

Fig. 4—Bowtie patterns indicating improper adjustment of DSB transmitter.

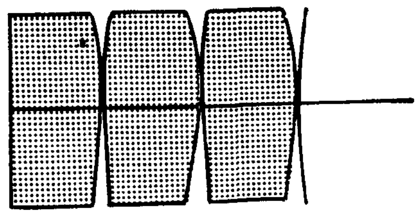


Fig. 5—Oscilloscope pattern showing envelope of a DSB transmitter operating with clipped speech.

cluded that it is highly advantageous to use speech clipping in the DSB transmitter in order to increase the average power output.

This technique is not new as AM operators have used clipped speech very effectively for years. Remember, as W2CRR pointed out, speech clipping cannot be used effectively with single sideband transmitters without greatly complicating their design. Another advantage that accrues is that the DSB transmitter power supply need not have dynamic regulation as good as that required by SSB transmitters since the envelope is of more constant amplitude when speech clipping is used.

Since clipping and filtering are so important, a simple filter-clipper circuit is presented here. It is designed to be inserted into existing speech amplifiers. Two precautions must be observed in its use:

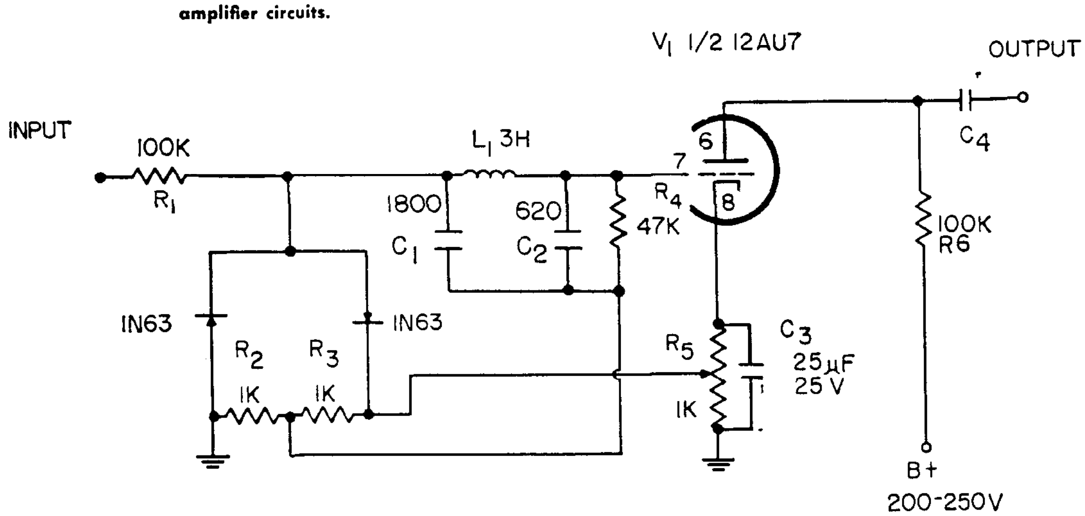
(1) The low frequency response of following stages must be good. RC time constants of couplings should not be less than .005 sec. For this reason, the clipper should not precede the existing pre-amplifier stages as their couplings are not usually this good.

(2) When the clipper filter is included in SSB/DSB exciters, it must be disabled in the SSB mode of operation.

Fig 6 is a schematic diagram of the filter-clipper circuit. The clipping function is accomplished by the two diodes which are biased beyond cut-off by the positive voltage obtained from R5. When the peak input voltage exceeds the bias voltage on either diode, the peak voltage is limited to the bias value. The filter, consisting of C1, C2, and L1, is a low-pass filter with a cut-off frequency of about 3000 cycles. A 10 Henry smoothing choke may be used for L1 if C1 and C2 are 470 mmfd and 330 mmfd, respectively. Either filter combination has nearly the same response, and about 10 db down at 4000 cps. The circuit has about a unity gain when the clipping is adjusted to 10 db and requires from .5 to 2 volts rms driving voltage from a high impedance source. The best place to install it is after the existing audio gain control. R5 then becomes the output level control and the existing gain control adjusts the amount of clipping. A 6AL5 dual diode will work just as well as the 1N63 diodes if it is preferred.

The information presented here should help in obtaining optimum perfomance from a DSB transmitter. The DSB transmitter will allow a much needed modernization of amateur bands with equipment that everyone can afford. ■

Fig. 6—Schematic diagram of speech clipper filter for installation in existing speech amplifier circuits.



ALL COMPONENTS ARE 10% TOLERANCE.
ALL RESISTORS ARE 1/2 WATT.
L_1 IS THE 3H POWER SUPPLY FILTER CHOKE FOUND IN ARC-5 RECEIVERS.