DSB Considerations and Data

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The trend by more and more amateurs to suppressed carrier phone communications is one of the greatest things that has ever happened to amateur radio. It is really a pleasure to operate in the segments of the bands which the sidebanders have pretty well taken over.

DSB offers a very easy way for anyone to try out suppressed carrier operation and it is hoped that this discussion will encourage more of you to try it. Let us not get off into any AM versus SSB versus DSB arguments—those arguments are for the professionals and the average amateur should steer clear.

Several DSB articles have appeared in recent issues of CQ showing the basic tetrode balanced modulator circuits used to suppress the carrier. These circuits may have either of two configurations:

1. Push-pull grids with parallel plates, or
2. Parallel grids with push-pull plates.

In either case, the screens are modulated with push-pull audio. Generally, the first configuration will be the best one to use since the push-pull components will be small and a pi-tank can be used in the output, the advantages of which are well known.

Hi-Level vs Linear

There are two approaches to medium or high power DSB. One is to make your final a high power balanced modulator. The other would be a low-power balanced modulator driving a linear amplifier. Unless you already have a *linear* amplifier (and know how to keep it linear) the high level approach is definitely recommended. If you do use a linear, don't forget that a single audio tone to the DSB exciter is a two-tone signal into the linear amplifier!

Most CW exciters have plenty of output to drive even the big tetrodes in a DSB final. Anyone with a two tube final (either push-pull or parallel) will only have to modify one RF circuit and split the screen grids to put the final on DSB.

Most any tetrodes may be used in the balanced modulator circuit and a tabulation of the recommended variables for the more common tubes is presented later. The general considerations of how to operate different tubes are best discussed one circuit at a time.

Grid Circuit

Each tube should definitely have its own grid bias resistor. Attempts at using a common bias resistor have resulted in aggravating any off-balance tendencies the tubes may have. The grid circuits should be operated as for normal class C Plate Modulated operation. The normal bias resistors for class C are used. The grid current is run up to normal values. It has considerable effect upon the resting plate current.

Bias may be partially from a battery, but should not be all battery bias. Partial battery bias will be found very handy if you want to include voice control operation.

Screen Circuit

The dc bias applied to the screens through the modulation transformer secondary has two effects. Most important is its effect upon the bow tie pattern crossover point. Just enough negative bias should be used to give a clean crossover and limit the resting plate current. Any further negative voltage will cause the two halves of the pattern to separate apart indicating distortion. The screen bias is necessary on some tubes to hold down the resting plate dissipation requirements. The bias battery or supply should have good regulation and should be by-passed heavily with several microfarads of capacitance. The smaller tubes (807's, 6146, etc.) work nicely with zero screen bias.

The screens must be by-passed for rf but not for audio, so the by-pass condensers should not be larger than .001 mfd and should be mica. The audio swing of the screens determines the amount of plate current the tubes can draw. As a conservative estimate of how much audio voltage you will need, take the normal plate modulated screen voltage and double it. Your audio *peaks* should hit this value (from center tap of mod. xfmr to screen) If you really want to run to full tube capability, you can check by heavily loading the final and running up the audio voltage till the RF no longer increases with increasing audio. At this point you are flattening on peaks because of emission limitation. Exceeding that audio voltage will only cause distortion. This maximum screen swing will be the same for a given tube type regradless of what plate voltage you run.

The screen modulator needs relatively small power output, but to modulate the larger tubes, voltage swings of about 800 volts peak are required. This is best accomplished with a step-up transformer. A pair of 6L6's in Class AB1 will modulate most any tubes, but step-up transformers with push-pull primary and secondary are a scarce commodity. The best solution available now seems to be to use a 10 or 20 watt class B driver transformer of 5:1 (pri to ½ sec) step down ratio. Using it backward will give you 1:1.25 primary to one-half secondary.

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Before long perhaps the transformer manufacturers will make available more suitable transformers.

Another possibility is to use a single 6L6 into the 117 volt winding of a small power transformer. This will give you roughly a 1:3 step up to half of the HV winding and works quite well.

Clipper-filter

While talking about modulators, it should be pointed out that speech clipping can be used to good advantage in DSB and is a very worthwhile feature to put in the speech amplifier. Clipping will give you a big boost in average talk power. Just remember to reduce low frequency response before the clipper-filter, and preserve both lows and highs after the clipper-filter.

Plate Circuit

As previously mentioned, the plate current of the DSB stage is pretty well determined by the audio swing on the screens. The way to more power then is obviously higher plate voltage. Bearing in mind that on normal AM the plate voltage swings up to twice the dc plate voltage, you can use up to twice the AM plate voltage on your DSB stage, and up to that value, the higher the better. Any given tube will work satisfactorily at its normal plate voltage, but it's a similar situation to linear amplifiers, if you really want to sock them, you must run up the plate and screen voltages.

This means that you have the following choices based on voltages available:

400-600 volts	6L6's, 2E26's, 6V6's, 6Y6's
600-1200 volts	807's, 1625's, 6146's
1200-1600 volts	?
1600-3000 volts	813's
2000-4000 volts	4-125A's, 4-250A's

Paralleling tubes on each side of the balanced modulator offers a powerful little package (four 807's give 300 watts p.e.p. *output*), but the paralleled output capacitances may make it difficult to get above 20 meters with four tubes.

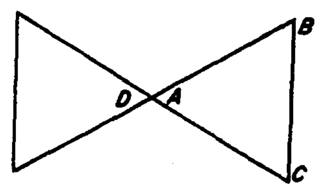
Since the plate current swing depends largely on the screen voltage swing, the best way to tune the DSB stage is not by plate current dip but by tuning for maximum output. With the tank circuit resonated, increase your loading to the maximum output point and stop. That's all there is to it. Some tank circuit conditions will cause greater plate current readings but reduced output.

The plate current meter, of course, does not read peak plate current, so if you want to figure your peak envelope power you must apply a factor. For sine wave modulation, the meter reading should be multiplied by 1.58 (1/.636). This figure and your plate voltage will give you peak envelope power input; you multiply by about 75% efficiency to get your peak envelope power output. If you are running relatively high plate voltage on your tubes you can estimate your peak output as four times the carrier output rating for AM phone service. This is conservative estimating, however, since with the low duty cycle of speech you can get a little better than this before distortion sets in from emission limiting or instantaneous downward plate voltage hits the screen voltage level.

Half of your peak power appears in each sideband which means a 3db disadvantage compared to SSB. The ability to select the best sideband at the receiving end buys some of this back, and clipping buys even more.

Checking Patterns

Just as in AM and SSB, it's always best to check your signal with an oscilloscope. The handiest pattern for checking DSB is the familiar bow tie. Apply audio on your horizontal amplifiers and rf direct on the vertical plates. This procedure is described in the handbooks. It is recommended that the audio be taken off the secondary of the modulation transformer for minimum phase shift. The audio voltage here will be way too much for your scope input though, so rig yourself a voltage divider of 1 megohm in series with a 10K resistor and pick audio off across the smaller resistor. Your bow tie should look like *fig. 1*.



Line AB and AC should be nice and straight. The A end of these lines has a tendency to bulge slightly with too much grid drive and may become concave with too little drive, so experiment here. If you have negative bias on the screens, there will probably be a little kink near A where the screen goes through zero, but this does not cause bad distortion. Peaks at B and C should be nice and sharp. If they are rounded you are flattening and probably due to overdriving the screens. If points A and D are separated so the points don't meet, you have too much negative bias on the screens. With high plate voltage you will find it easier to get a good bow-tie pattern. If your tubes are not balanced, one half of the pattern will rise higher on peaks than the other side. One half of the pattern represents each tube, but has no relationship to the upper and lower sideband. The side-bands will be identical in any case.

The bow-tie pattern won't show up audio distortion so you will find it interesting to

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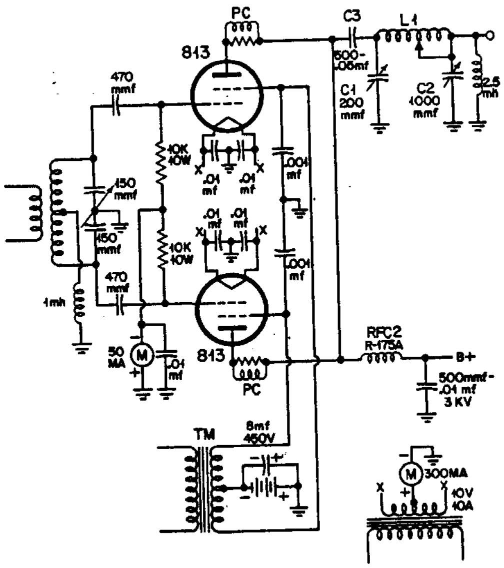
	6V6	6BQ6/ 6DQ6	807/ 1625	6146	813	813	813	4-250A
Plate Volts	500	600	1250	1000	1500	2000	2600	4000
Screen Volts	0	0	0	0	–22.5	–67.5	–90	–65
Plate Current Resting	10	25	30	25	100	55	60	80
Plate Current Full Whistle	50	150	100	125	205	245	265	300
PEP Output	30	100	150	150	380	600	840	1500



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shift to an rf envelope pattern by switching to internal sweep on your horizontal axis. By using a steady audio note you can synchronize and see how well your audio is doing.

If you have established the proper conditions you will have a good bow-tie shape and you will be pleased to note that the tuning controls don't affect the shape much. If you detune anything, about all that happens is you get less than maximum output.

Fig. 2 is a complete circuit diagram for 813's. Exactly the same circuit is applicable for all tetrodes—you can use lower voltage components for smaller tubes of course.

Table 1 shows DSB operating conditions for some of the more common tubes. Don't worry if you don't have the exact voltages called for, these are the ones tried by W2CRR, W2HNH, W2SBI, and K2KID. Pick out the tubes you want and have a go at DSB. You'll like it! ■

BOOKS

Electricity and Electronics—Basic

Interesting book, profusely illustrated. After reading this book you will have a darned good basic understanding of electronics and electricity . . . how it works, etc. The junior op or XYL will have a pretty good background for really understanding radio if they start with this introduction. They will see how electricity is used around the house and the car. Since all of the theory is related to things that everyone isfamiliar with this book certainly makes for a painless and interesting source of fundamentals. 245 pages, $4.50. Published by the American Technical Society.