How to Determine Driver-Transformer Requirements for the Modulator

By
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After selecting the tubes and power requirements for the modulator, and the class of service for the modulator tubes and driver, the amateur is faced with the problem of selecting a suitable driver transformer for the modulator. A simple, straightforward procedure for calculating the turns ratio of the driver transformer for class AB_2 or class B service, using a few simple equations and published tube data, follows:

1. Refer to your tube manual or tube bulletin and select from the "Typical Operation" data for the driver tube (or tubes) the load resistance, R_L, for the desired value of plate voltage. For push-pull operation, the effective load resistance is given as the plate-to-plate value.

2. Determine the effective grid resistance, R_g, *of a single modulator tube* from the following approximate relation:

$$R_g = \frac{E_g^2}{8P}$$

where: E_g is the peak af grid-to-grid voltage (given in the published tube data).
P is the max.-signal driving power (given in the published tube data).

3. Substitute the values of R_L and R_g in the following formula:

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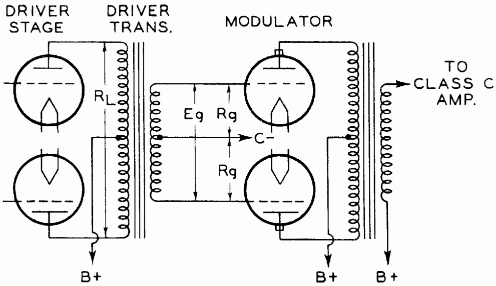

Fig. 1. For a push-pull driver stage, R_L represents the plate-to-plate load resistance. Note that R_g applies to a single modulator tube and that E_g is the grid-to-grid voltage.

$$\text{turns ratio} = \sqrt{R_L / R_g}\,.$$

If R_L is greater than R_g, the ratio is step-down; if R_L is less than R_g, the ratio is step-up. The proper impedance ratio of the entire primary winding to one-half of the secondary winding should be the same as the ratio of the load resistance, R_L, to the effective grid resistance, R_g, of a single modulator tube.

The above procedure is illustrated below:

Example. A pair of 811-A tubes have been selected to operate as class-B modulators with a plate-supply voltage of 1250 volts. The required maximum-signal driving power, P, and the peak af grid-to-grid voltage, E_g, are given in the published data (under ICAS conditions*) as 6.0 watts and 175 volts, respectively. In

* *Intermittent Commercial and Amateur Service.*

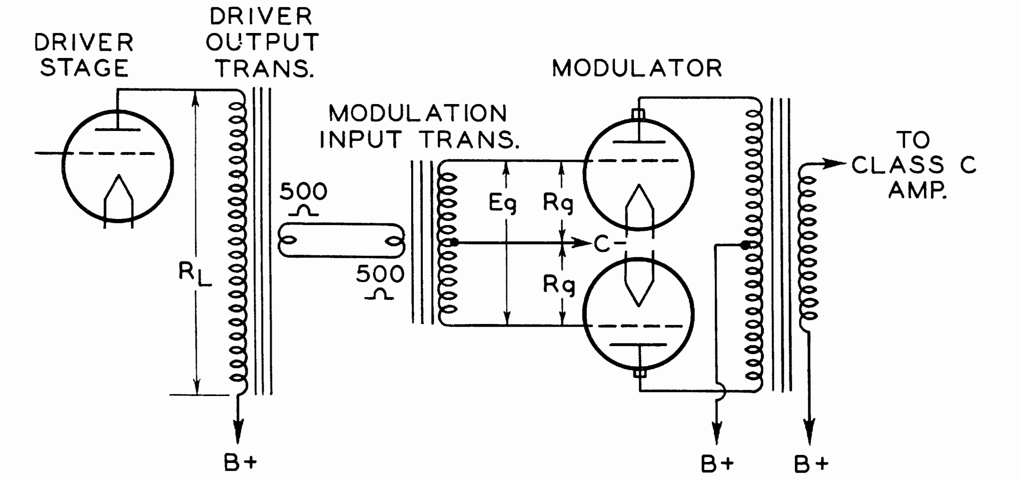

Fig. 2. If a 500-ohm line is employed between the driver stage and the modulator, 500 ohms must be substituted for R_g in the formula for the turns ratio of the driver output transformer. Similarly, 500 ohms should be substituted for R_L in the formula for the turns ratio of the modulator input transformer.

order to obtain ample driving power and to allow for circuit losses, a pair of push-pull 2A3's (operating class AB_1, with fixed bias and 300 volts on the plate) was selected to drive the modulator. The power output available from the 2A3's is approximately 15 watts.

1. The plate-to-plate effective load resistance for the push-pull 2A3's is given in the tube data as 3000 ohms.

2. The effective grid resistance of a single 811-A is

$$R_g = \frac{E_g^2}{8P} = \frac{(175)^2}{8\,(6)} = \underline{638 \text{ ohms.}}$$

3. The turns ratio of the driver transformer (full primary/one-half of the secondary) is

$$\sqrt{\frac{R_L}{R_g}} = \sqrt{\frac{3000}{638}} = \frac{2.16}{1} \quad \text{(step-down)}.$$

If a 500-ohm line is to be used between the driver stage and the modulator, the turns ratio of the driver output transformer and the modulator input transformer may be determined as follows:

1. The turns ratio of the driver output transformer (primary/secondary) is

$$\sqrt{\frac{R_L}{500}} = \sqrt{\frac{3{,}000}{500}} = \frac{2.45}{1} \quad \text{(step-down)}.$$

2. The turns ratio of the modulator input transformer (full primary/one-half of the secondary) is

$$\sqrt{\frac{500}{R_g}} = \sqrt{\frac{500}{638}} = \frac{1}{1.13} \quad \text{(step-up)}.$$

In addition to having the proper turns ratio, the transformer selected should be capable of handling the developed power. The use of a vari- or multi-match type transformer provides a wide range of impedance ratios as well as versatility for possible future modifications.

A PRECISION "SLICK WHISTLE" FOR 3.5 TO 4 Mc

(Continued from page 5)

quency end of the VFO tuning range (3,500 Kc) should fall near the first division mark on the dial. Several trial-and-error runs may be necessary to select the proper 180° portion of the tuning capacitor and the proper setting of C_3 to make the full 500 Kc of the 80-meter band cover the 500 dial divisions. If your station has more than one operator, it is a good idea to seal the final setting of C_3 with sealing wax immediately after the VFO is calibrated!

RF output at the output connector on the oscillator box was measured and found to be 45 volts rms with only a five-volt drop at the other end of the band. Connection to the transmitter should be made with unshielded wire of not more than two feet in length. The use of coaxial cable here is not recommended because its capacitance would shunt the high-impedance output of the buffer.*

Performance

The original calibration of this VFO was checked recently and found to be substantially as accurate as it was the day the curve was plotted. Time and again, schedules were kept on a pre-arranged frequency by returning to the same number on the VFO dial.

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* This VFO was installed in the transmitter relay rack. If the VFO is to be located on the operating table several feet from the transmitter, coax may be used if a cathode follower is inserted between the 6AG7 buffer and the coax. (See the first paragraph on pg. 3 of the June-July, 1953 issue of HAM TIPS.