Output Transformer Impedance Matching

By ROBERT B. TOMER
Chief Eng., Symphonic Radio & Electronic Corp.

Simplified chart provides output transformer turns ratio without lengthy mathematical calculations.

TRANSFORMER impedance matching is a problem frequently encountered by the experimenter or serviceman. Usually, a transformer is obtainable which is designed by the manufacturer to do the particular job desired and it is only necessary to connect the unit as indicated to obtain entirely satisfactory results. There are occasions when such a transformer is not readily available or where the individual already has several good transformers on hand whose specifications have become lost. It is possible, especially in the case of output transformers, to use one transformer to do a large variety of quite different jobs. The reason for this is that a transformer used to couple a tube into its load, never acts as the load itself, but only as the means for "reflecting" or translating a load of one characteristic into a load of another characteristic such that it corresponds to the optimum value for the tube being used.

Transformers reflect impedance from one circuit to another in direct relationship to their turns ratios. The turns ratio is the ratio of primary turns to secondary turns. Impedance is reflected as the square of this ratio. That is, if the turns ratio is 2 to 1 the impedance across the primary will be reflected into the secondary as 4 to 1. When the turns ratio is 3, the impedance ratio will be 9, etc. The turns ratio of any transformer can be determined with reasonable accuracy by measuring the voltage ratio since in a perfect transformer they would be identical. The voltage ratio can be measured by placing any known a.c. voltage across one winding and measuring the resulting induced voltage across the other winding. For best results the voltmeter used for these measurements should draw little or no power, but even a very simple rectifier type a.c. voltmeter will give results that are entirely adequate for all practical purposes.

In order to determine what turns ratio is necessary to couple a given tube to a given loudspeaker voice coil, it is useful to know the formula:

$$\text{Turns Ratio} = \sqrt{\frac{\text{Load Resistance of Tube}}{\text{Voice Coil Impedance}}}$$

This says that the square root of the optimum load resistance of the tube, as taken from the manufacturer's specifications in a tube manual, divided by the voice coil impedance is equal to the turns ratio. For example, if it is desired to couple a 50L6 to a speaker having a voice coil impedance of 3.5 ohms, what turns ratio is required?

$$\sqrt{\frac{2000}{3.5}} = \sqrt{570} = 24 \text{ Turns ratio}$$

This same information can be obtained from the chart without the need of calculation by drawing a line through the 3.5 position on the lower reference line and continuing upward until it intersects the 2000 ohm line and then following the oblique line upwards and to the right until it intersects the outer arc. At this point the proper turns ratio can be read directly.

Through the use of this chart it becomes possible to adapt many transformers for uses other than those for which they were originally designed. A transformer originally designed for use with a 50L6 and a 3.5 ohm voice coil would have a turns ratio of 24. This same transformer could be used to match a 6V6 into an 8 ohm voice coil. Or two 3.5 ohm voice coils could be connected in series, with a small loss of power in each speaker, and used in conjunction with this same transformer and the 6V6. Output transformers usually have their voice coil windings on the outside so that it becomes very easy to remove a few turns if it is desired to raise the turns ratio. This same transformer could be changed from a turns ratio of 24 to one of 30 or 35 by removing a few turns from the outside winding. Thus, many possibilities are available to the experimenter or serviceman through the use of this simple technique. Even the multi-tap transformer can be put to more varied use by this method and in case the chart which comes with it has been lost, you can determine for yourself what the various taps can be used for. —30—

Chart that may be used to determine turns ratio of output transformers.