Lawrence Berkeley National Laboratory
Recent Work

Title
CASCODE AMPLIFIER CHARACTERISTICS

Permalink
https://escholarship.org/uc/item/4840h7mf

Author
Evans, Frank.

Publication Date
1955-07-27
DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.
CASCODE AMPLIFIER CHARACTERISTICS

Frank Evans

July 27, 1955

Printed for the U.S. Atomic Energy Commission
CASCODE AMPLIFIER CHARACTERISTICS

Frank Evans
Radiation Laboratory
University of California
Berkeley, California

July 27, 1955

In a pentode amplifier application it is frequently desirable to use two triode sections arranged in cascode. Approximate static characteristics, usually needed in the design calculations, can be found very quickly from the corresponding characteristics of the triode under consideration.

Figure 1 illustrates a circuit that might be used to determine the static characteristics experimentally. Given a value of the upper grid voltage, $E_{c2}$, one can determine a family of $E_b$-$I_b$ curves with $E_{c1}$, the bias voltage, as a parameter. These will appear to be similar to pentode characteristics, but with some important differences.

Assume $E_{c1}$ and $E_{c2}$ fixed for the moment. As $E_b$ is increased to sufficiently large values, $E_{b1}$ will increase until it approaches $E_{c2}$, at which time it will level out to a value very near $E_{c2}$ because of the clamping action of the upper triode. $I_b$ will also level out to a saturation value $I_b'$ corresponding to $E_{b1} \approx E_{c2}$. As $E_b$ is reduced to sufficiently low values, the upper triode goes into grid conduction and the voltage $E_{b2}$ is determined from the zero bias curve for the particular $I_b$.

Once $E_{c2}$ is set, then the cascode characteristic corresponding to a particular $E_{c1}$ can be derived by determining $E_{b1}$ on the $E_{c1}$ bias triode line, and $E_{b2}$ on the zero bias triode line, both as a function of $I_b$ up to the saturation level $I_b'$.

An example is given in Fig. 2 for the 6BC4. $E_{c2}$ is given as 150 volts. For the particular curve shown in detail $E_{c1} = -1$ volt. $I_b' = 20.5$ ma is shown as the value of $I_b$ when $E_{b1} = E_{c2} = 150$ volts. The point "x" is obtained for $I_b = 15$ ma. $E_{b1}$ is defined by the triode curve to be 132 volts at this point. Since the upper triode is in grid conduction, $E_{b2}$ from the zero bias curve is 93 volts. $E_b = E_{b1} + E_{b2}$ then is shown on the point 'x' as 225 volts. Other points obtained in the same manner are shown and a continuous line is drawn through these and folded over at the knee to meet the $I_b'$ line. Other curves for the family $E_{c2} = 150$ volts can be drawn but are not shown here.

Characteristics obtained in this manner are not precise but should be well within the limits of the manufacturer's tolerances on $g_m$, etc. The upper grid
circuit may act as a plate load for the lower tube and tend to shift the lower part of the cascode curve in Fig. 2 to the left. In addition \( I_b \) should approach \( I_b' \) gradually--more so with low-\( \mu \) tubes.

Increasing \( E_{c2} \) has the effect of spreading out the cascode curves vertically and thus increasing the \( g_m \); however, the knee will be shifted to the right and higher plate-supply voltages are required to get into the "pentode" region.

The \( I_b' \) saturation lines are usually the ones of primary interest. These can be found quickly by the intersection of the \( E_b = E_{c2} \) line with the triode curves. The knee can be located approximately by assuming grid conduction at \( I_b' \) and marking off \( E_b = E_b1 + E_{b2} \) as before. Determining one knee should be sufficient, as the others occur at about the same voltage.

This work was performed under the auspices of the U.S. Atomic Energy Commission.

Permission for publication of this information in whole or in part is granted by the author and the University of California Radiation Laboratory operated for the United States Atomic Energy Commission.