
Subject: Quick and simple formulae for Ra
Posted by [Damir](#) on Wed, 26 Jan 2005 20:14:26 GMT
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In transformer - coupled output stage with output triode we must do a graphical load - line analysis to find load resistance Ra (primary resistance, or reflected secondary load). Ra is max. AC voltage "swing" divided with max. current "swing" through the load, or $R_a = U_{a\ pp} / I_{a\ pp} = U_{a\ p} / I_{a\ p} = U_{a\ rms} / I_{a\ rms}$ Power at the primary: $P_a = U_{a\ rms}^2 / R_a = I_{a\ rms}^2 * R_a = U_{a\ rms} * I_{a\ rms}$ Note that $I_{a\ p} = I_{a\ dc}$, $I_{a\ pp} = 2 * I_{a\ dc}$, $I_{a\ rms} = I_{a\ dc} / 1,4142$ The "goal" is to avoid graphic analysis, and find the simple formulae, "good enough" for "everyday use". Our triode output tube with its "bias" U_{gk}, can have max. peak AC input voltage in class A1 equal to U_{gk}, or U_{gk rms} = U_{gk}/1,4142. With very high load Ra, AC voltage at the load Ra is: $U_a = \mu * U_{gk}$ But, our "real" load Ra form voltage divider with tube plate resistance rp, and voltage at the load Ra is actually lower: $U_a = (\mu * U_{gk}) / (1 + r_p/R_a)$ And from $R_a = U_a / I_a$, we have $U_a = R_a * I_a$ If we put together these equations: $R_a * I_a = (\mu * U_{gk}) / (1 + r_p/R_a)$, and $R_a * I_a = (\mu * U_{gk}) / ((R_a + r_p)/R_a)$, and $R_a * I_a = (R_a * \mu * U_{gk}) / (R_a + r_p)$, and $I_a = (\mu * U_{gk}) / (R_a + r_p)$, and $R_a + r_p = \mu * U_{gk} / I_a$, and finally: $R_a = ((\mu * U_{gk}) / I_a) - r_p$ FORMULAE FOR Ra What does this mean in practice? If we have some DC operating point for our output triode, say 300B - U_{ak}=400V, I_a=80mA, U_{gk}=-85V and we know (about) rp and mu from tube manuals (simplification, assumed that rp and mu are constant, but error is minimal and negligible). Say, rp = 700 Ohms and mu = 3,9. Then: $R_a = ((3,9 * 85) / 0,08) - 700 = 3443,75$ Ohms ~3,5 kOhms In agreement with load - line analysis and tube manual data!
